FARMING ACTIVITIES AND RESPIRATORY HEALTH IN SCHOOL AGE CHILDREN

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Abstract

There is limited study of the relationship between current farming exposures and childhood asthma, respiratory symptoms, and lung function. This thesis examined the prevalence of asthma in children living on and off farms and the risk of asthma and respiratory symptoms of children exposed to farming activities as well as the relationship between participation in selected farm related activities and lung function values in school age children.

The analysis for this thesis was based on data collected from a cross-sectional study conducted in 2004 of 636 children ages 6-13 from an agricultural community in rural Saskatchewan. Parents on behalf of children completed a questionnaire of respiratory health and environmental exposures. Asthma was defined as doctor diagnosis of asthma. Respiratory symptoms were determined by report of cough, wheeze, phlegm. Individual farming activities assessed were; haying, harvesting**,** moving or playing with hay bales, feeding livestock, cleaning or playing in barns, cleaning pens, and emptying or filling grain bins. The health assessment, conducted at the schools with children, included measurements of height, weight, skin prick test for atopy and lung function (FEV_1, FVC, $FEV_{25\text{-}75}$, FEV_1/FVC ratio).

There were 553 subjects with questionnaire data for a response rate of 86.9%. Of those subjects participating in the study, lung function was available for 532 subjects. The overall prevalence of asthma was 18.8% and the prevalence of respiratory symptoms was 39.8%. The prevalence of asthma or respiratory symptoms did not differ between children who lived on farms or in towns.

After adjusting for significant or clinically important risk factors, children who were exposed to emptying and filling of grain bins were more likely to have asthma (OR=2.42, 95%CI:1.19-4.92). Children with respiratory symptoms were more likely to be exposed to haying activities (OR=1.92, 95% CI:1.03-3.56), playing on or near hay bales (OR=1.93, 95%CI:1.2 -2.96) or cleaning pens (OR=2.55, 95% CI:1.04-6.26). Lung function variables were not associated with participation in any of the seven farming activities tested.

Although there were no differences in the prevalence of asthma and respiratory symptoms between farming and non-farming children, certain farming practices may be important in the etiology of asthma and related respiratory symptoms in children.

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Dedication

I would like to dedicate this thesis to my wonderful husband, Jeff Farthing and our children, Matthew, Rebecca and Mikeal, who have given me their love and support throughout this process and are the reason behind everything that I do. Also to my parents, Drs. Jim and Maureen Tynan, whom I hope I have made proud by this accomplishment.

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List of Abbreviations

The following is a list of commonly used abbreviations in this thesis:

AHR	Airway Hyper-responsiveness
BHR	Bronchial Hyper-responsiveness
CCG	Canadian Consensus Guidelines
CCHSA	Canadian Centre for Health and Safety in Agriculture
CI	Confidence Interval
ETS	Environmental Tobacco Smoke
FEV_1	Forced Expiratory Volume in the first second
FVC	Forced Vital Capacity (litres)
FEF_{25-75}	Forced Expiratory Flow at 25-75% of Forced Vital Capacity (litres/second)
ISAAC	International Study of Asthma and Allergies in Children
NPHS	National Population Health Survey
OR	Odds ratio
SD	Standard Deviation
SE	Standard Error
SES	Socioeconomic Status
SPSS	Statistical Package for Social Sciences
SPT	Skin Prick Test
US	United States

Chapter 1: Introduction

1.1 Background to the Study

Asthma is a condition of the airways that is characterized by episodes or exacerbations of inflammation, bronchoconstriction, and excessive mucus production.[1,2,3] Inflammation results in narrowing of the airways in the lungs which causes increased symptoms such as wheezing, coughing, chest tightness and shortness of breath.[4] The prevalence of asthma and respiratory symptoms are increasing in children. In 1998, asthma prevalence for children worldwide was 10%; currently in 2007 it is between 16 and 20%.[5] According to repeated studies by Burr et al. the prevalence of ever asthma in children has increased and continues to increase in school age children.[6] In Canada asthma affects approximately 15% of school age children.[7-10] While research has yet been able to adequately explain the reasons for these increases in prevalence, these increases have been fairly rapid, suggesting changing environmental factors, as opposed to genetic factors, as the potential cause.[11]

In the last 25 years, morbidity and mortality from asthma have increased worldwide, particularly among those less than 35 years of age.[12] In Canada, asthma is the most common chronic condition of childhood.[7-10] Exacerbations are the major cause of morbidity and mortality in asthmatic children. Children with exacerbations may also experience decreases in lung function. Childhood asthma places demands on the health care system that continue into adulthood. In Canada, health care costs related to asthma were 19 billion dollars in 1993.[13] Asthma exacerbations are a risk for all children with asthma and are characterized by worsening symptoms, airflow obstruction, and an increased requirement for rescue bronchodilators. [2] Children with poorly controlled asthma often have time away from school, sports, or other activities that affect their quality of life.[7, 14] According to the 1996-97 National Population Health Survey (NPHS), 35% of individuals with current asthma had been restricted by asthma in their daily activities with 13% for more than 5 days in the previous year.[15]

In order to reduce risk factors that could help to decrease the morbidity and mortality associated with asthma, it is necessary to identify the potential risk factors and protective factors for childhood asthma. Allergens are known to be associated with later development and exacerbation of asthma in children. Environmental exposures in childhood are linked to the continuation of asthma into adulthood. Parental histories of allergy or asthma are important risk factors for asthma.[16]

Occupational exposures to farming activities are known to be associated with lowered lung function,[17] asthma and respiratory symptoms,[18] and allergy [19,20] in adults. Whether these are also important risk factors for children is not established. There are conflicting reports of the importance of the farming environment in children who either reside on farms or visit farms. [21-28] Both a lower risk,[21-24] and an increased risk [25-28] of asthma and allergy in children who were raised on farms have been identified. Also, there has been limited study of the associations between farming and asthma or respiratory symptoms in Canadian children. A study of farming and non-farming children living in Saskatchewan showed that children who lived on a farm were more likely to wheeze and less likely to have asthma if they participated in routine farming activities. This study, however, did not explore the association between specific farming activities and lung function.[29]

1.2 Purpose of the Study

The purpose of this study was to examine the association between asthma, respiratory symptoms and selected farming activities including haying, harvesting, moving or playing with hay bales, feeding livestock, cleaning or playing in barns, cleaning pens, emptying or filling grain bins, in children in Grades 1 to 8 who participated in the 2004 Humboldt study. As well, this study examined the relationship between pulmonary function variables [forced expiratory volume in one second (FEV_1), forced vital capacity (FVC), forced expiratory flow between 25% and 75% of FVC (FEF_{25-75}) and FEV_1/FVC ratio] and farming activities in this same study population.

Chapter 2: Literature Review

2.1 Asthma

Asthma is a disorder of the bronchial airways characterized by periods of inflammation and reversible bronchospasm (prolonged contraction of the airway).[4] Asthma is sometimes referred to as “reactive airway disease”.[4] Children experiencing an asthma episode usually present some or all of the following symptoms; wheeze, cough, shortness of breath, increased respiratory effort, mucous production, and/or chest tightness. Characteristically there is variable airflow limitation and a variable degree of hyper-responsiveness of airways to endogenous or exogenous stimuli.[30] Asthma mortality and morbidity have been on the rise since the mid-1980s.[17, 31] Asthma affects approximately 15% of Canadian children, making it the most common chronic disease in childhood.[7-10] Asthma is primarily an inherited disorder and is strongly associated with atopy (allergy) in children.[32- 34] Environmental factors such as viruses, allergens and pollutants interact with the genetic factors to produce symptoms of this disease. When children with asthma are exposed to certain allergens such as animal dander, pollens, grasses, molds or non-allergic irritants such as; perfumes, cold air, respiratory viral agents, cigarette smoke, the airways can become inflamed leading to airway hyper-responsiveness (AHR) and bronchoconstriction.[35] In order to prevent further episodes or relieve symptoms, it appears important to implement environmental controls for irritants and allergens along with the use of inhaled corticosteroid and/or bronchodilator medication.[36]

2.2 Risk Factors for Asthma

The definitive cause of asthma has not been established but various factors are thought to be influential in the development of asthma.[37] Genetic factors associated with asthma include age, gender, atopy, parental history of allergy or asthma, and history of bottlefeeding. In young children, environmental factors known to be associated with asthma include environmental tobacco smoke (ETS) from parental smoke in the home, environmental exposure to dust mites and endotoxin, home dampness/mold, gas heating in the home, single family homes, exposure to pets, farm exposure in the first 12 months of life, and the type of farm exposure in first 12 months of life.[3,43,45-48,50,51]

2.2.1 Gender and Age

The relationship of age and sex to asthma is well established. In children, asthma symptoms or diagnosis most often occur by age 5 or 6. The Student Lung Health Study conducted by Health Canada in 1995-1996 on children up to age 19 found a diagnosis rate of 8.5% before the age of 1 and 40.3% before the age of 5, and a first symptoms rate of 15.3% at the age of 1 and 48.5% by the age of 5.[32] Hessel et al. found that 20.2% of children with asthma were diagnosed before the age of 1, and 67.4% before the age of 5.[38]

Most studies of asthma in children show that asthma is more common among male children than female children.[5,12,15,32,39] Females however, begin to have higher rates of asthma than males after age 14 and this continues through adulthood.[10] Research has also shown that asthma is more common in children than adults.[32,33]

2.2.2 Atopy and Asthma

Atopy has been found to be a risk factor for asthma in many studies.[40] Asthma is characterized as an atopic disease however not all children with atopy develop asthma. Von Mutius et al. noted that a family history of asthma or atopy increased the risk of asthma in children.[41] Von Hertzen et al. in a study of 1,096 children ages 7 to 16 in Russia and Finland found a parental history of atopic disease to be associated as a risk factor for asthma and atopy.[42] Family history of atopic disease is related to asthma but the intricacies of the genetic mechanism by which this occurs are not fully understood.

2.2.3 Breastfeeding

Breastfeeding appears to offer some protection from the development of asthma. A case control study of 600 children under the age of 13 in Sri Lanka by Karunasekeran et al. found that continuing breastfeeding beyond 6 months is important.[40] Children breastfed for less that six months were more likely to have asthma [odds ratio (OR)=2.5, 95% confidence interval (CI): 1.5-4.2] than children who were breastfed longer.[40] Using data from the National Longitudinal Survey of Children and Youth, Lethbridge et al. found, in 11,077 2 to 7 year olds, that children were less likely to be diagnosed with asthma if they had been breastfed (OR=0.78, 95% CI: 0.62-0.98).[9]

2.2.4 Smoking

Maternal smoking during pregnancy and exposure to tobacco smoke in the home have also been found to be risk factors for asthma. Von Hertzen et al. found indoor exposure to tobacco smoke to be a risk factor for atopy and asthma.[42] A study by Chen et al. of 892 subjects ages 6 to 17 in Humboldt, Saskatchewan, found that the number of household smokers, the total daily cigarette consumption by household members, and the number of cigarettes smoked daily were directly associated with asthma prevalence.[43] In a study of 19,076 children age 6 months to 18 years of age living in non-urban United States (US) communities, Higgins et al. found exposure to tobacco smoke to be a risk factor for asthma (OR=1.45, 95% CI: 1.26-1.63).[44]

2.2.5 Damp Housing, Mold and Gas Heat

Damp housing, the presence of mold, and gas heating have been found to be risk factors for asthma and allergies in children. In a population-based, 6 year prospective cohort study of 1,984 children ages 1 to 7 in Finland, Jaakkola et al. found an increased risk of asthma related to mold odor in the home.[45] Damp home environment was associated with an increased risk of asthma (OR=1.75, 95% CI: 1.26-2.43) in a prospective cohort study by Wickman et al. of 4,089 children in Stockholm.[46] Mold/mildew in the home in the past 12 months was associated with an increased risk of asthma (OR=1.62, 95% CI: 1.47-1.78) in the North Carolina School Asthma Survey of 128,568 students in Grades 7 and 8.[3] Mommers et al. in a German study of 1,191 children ages 7 and 8 found an increased risk of asthma symptoms with long term exposure to dampness (OR= 2.98, 95% CI: 1.14-6.67) and with exposure to pets (OR=2.18, 95% CI: 1.39-3.42).[47] A survey of 25,393 12 to 14 year old students in Great Britain by Burr et al. showed an increased risk of respiratory symptoms associated with gas heat in the home (OR=1.10, 95% CI: 1.03-1.17) and with furry pets in the home (OR=1.08, 95% CI: 1.01-1.14).[48] Von Hertzen et al. found current indoor pet (cat, dog) to be associated with less asthma.[42] Oberle et al. using a cross-sectional questionnaire with parents of 8,216 German school children ages 5 to 7 found a significantly lower risk of asthma if the child was extensively exposed to cats since the first year of life (current cat and cat allowed in child's bedroom) (OR=0.28, 95% CI: 0.10-0.62).[49]

2.3 Asthma Prevalence in Farming Populations

Studies have shown a lower prevalence of asthma and respiratory symptoms in farm children compared to non-farm children, particularly if that exposure was early in life.[24,37] Studies of children living on farms have shown that if children were fed raw milk or were exposed to high levels of endotoxin in the first year of life they were less likely to be atopic or have asthma in childhood.[24,37] This protection seen in some studies with children contrasts with the literature suggesting increased respiratory disease in adult farmers exposed to high levels of endotoxin.[17-20] There are studies that explicitly contradict this trend toward a lower prevalence in children, instead showing an increase in asthma prevalence for children living on farms.[25,50,51]

A number of international studies have looked at the relationship between asthma and respiratory symptoms in children who live on farms. Table 2-1 presents studies that have examined the association between asthma and being raised on a farm. All studies reported were published between 1999 and 2006. The studies were conducted with European and North American populations.

A study by Alfven et al. was conducted in Sweden on 14,893 children age 5 to 13 living in Austria, Germany, the Netherlands, Sweden and Switzerland.[52] In this study asthma was defined as; a doctor diagnosis of asthma, and wheeze was defined as; at least one episode of wheezing during the last 12 months. There was significantly less

Table 2-1 Studies comparing the prevalence of asthma and respiratory symptoms between farming and non-farming populations

Study	**Year***	**Country**	**Age**	**Design**	**n**	**Definition of Asthma**	**Association OR (95% CI)**
Alfven et al[52]	2006	Germany Austria Netherlands Sweden Switzerland	5-13	CS	14893	Dr. dx	Farm living and asthma 0.74 (0.60–0.92) Farm living and wheeze 0.78 (0.62–0.99)
Kilpelainen et al[53]	2002	Finland	18-25	CS	10667	Dr. dx	Farm /- and asthma NS
Riedler et al [23]	2000	Austria	8-10	CS	2283	Dr. dx	Prevalence of asthma 1.1% if live on a farm, 3.9% if not living on a farm (p=0.02)
Braun-Fahrlander et al[54]	1999	Switzerland	6-15	CS	1620	Ever asthma (questionnaire)	Farming family and asthma 1.17 (0.64-2.13). Farming family and wheeze 0.77 (0.38-1.58)
Brunner et al[55]	2005	United States	Grades 9-11	L	13490	Dr. dx	Farm residence and asthma 0.78 (0.65-0.94) Farm residence and wheeze 0.84 (0.72-0.98)
Aref et al [56]	2003	United States	6-16	CS	1500	Dr. dx	Urban living and asthma 1.47 (1.05–2.06) Urban living and wheeze 1.37 (1.01–1.87)
Chrischilles et al[27]	2003	United States	6-14	CS	3090	Dr. dx	Farm/wheeze 0.77 (0.60-0.98) Farm/non-farm for asthma dx NS
Ernst et al [21]	2000	Quebec	12-19	CS	1119	AHR on methacholine challenge and wheeze	Raised on a farm and asthma 0.59 (0.37-0.95) Raised on a farm and wheeze 0.70 (0.52-0.95)

*=year published; CI= confidence interval; L=longitudinal; CS=cross-sectional; dx= diagnosis; NS= Not significant; AHR=airway hyperresponsivenes

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asthma among children who currently lived on a farm compared to children who did not live on farms (OR=0.74, 95% CI: 0.60–0.92). There was also significantly less current wheeze among children who live on farms (OR=0.78, 95% CI: 0.62–0.99).[52]

Kilpelainen et al. conducted a study by questionnaire on 10,667 Finnish first year university students 18 to 24 years old in 2000.[53] Questions were asked to examine the effect of childhood residential environment (living on a farm at ages 0 to 6; living in a rural area, but not a farm, ages 0 to 6; and living in an urban area ages 0 to 6). Farm environment compared with rural non-farm environment was not significant among asthmatics (3.7 vs 4.7 %). Riedler et al. in a 2000 cross-sectional study of 2283 children ages 8 to 10 years from mostly rural Austria found a lower prevalence of asthma (1.1%) in Austrian children who lived on a farm compared with those who did not (3.9%).[23]

Braun-Fahrlander et al. in a study of 1620 Swiss children ages 6 to 15 found the association between asthma in children from farming families compared to children from non-farming families to be OR=1.17, 95% CI: 0.64-2.13.[54] Risk of wheeze was (OR=0.77, 95%CI: 0.38-1.58) for children from farming families compared to children from non-farming families.

A two year longitudinal study by Brunner et al. of 13,490 attending Grades 9 to 11 in Minnesota found those living on a farm were less likely than those not living on a farm to report wheezing in the past 12 months (OR=0.84, 95% CI: 0.72- 0.98).[55] They were also less likely to report ever having an asthma diagnosis (OR=0.78, 95% CI: 0.65-0.94). A cross-sectional study by Aref et al. of 1500 Texan children ages 6 to 16 defined an urban area to be any area with the population over 50,000 and found children who lived in urban areas were more likely to report asthma (OR=1.47, 95% CI: 1.05–2.06) and more likely to report wheeze (OR=1.37, 95% CI: 1.01–1.87) compared to children living in rural areas.[56]

Chrischilles et al. studied 3,090 children ages 6 to 14 years from 2000 through 2002 in rural Iowa and found that the children who lived in farms were less likely than those who lived in town to wheeze (OR=0.77, 95% CI: 0.60-0.98).[27] The results for asthma diagnosis were not significant, farm and non-farm children were equally likely to be given an asthma diagnosis.

A Quebec study by Ernst et al. of 1,199 rural school children ages 12 to 19 who either currently lived on a farm or have never lived or worked on a farm, evaluated questionnaire information about farming, asthma and wheeze as part of their study.[21] Asthma was defined as a reported occurrence of wheeze in the last 12 months and demonstrated airway hyper-responsiveness on methacholine challenge. Results showed the odds ratio for asthma having been raised on a farm were, (OR=0.70, 95% CI: 0.52-0.95) for wheeze, and (OR=0.59, 95% CI: 0.37-0.95) for asthma.

In summary, the majority of studies examining the associations between asthma or respiratory symptoms such as wheeze and residing on a farm have shown that farm living is negatively associated with asthma. However, there are some studies where there have been either a positive association or no association between farm living and asthma.

2.4 Association between Farming Activities and Asthma and Respiratory Symptoms

Studies examining the respiratory effects of exposure to the farm environment have primarily been conducted with the farm worker. Farmers exposed to the various activities on farms are known to experience wheeze, cough, and phlegm during and post activities.[18,20] Associations with asthma and decline in lung function have also been reported.[17,19]

Kirychuk et al. studied 300 poultry workers, 241 grain farmers and 206 non-farming control subjects in Saskatchewan, Alberta, and Manitoba.[20] The poultry workers in the study, particularly those who worked in cage-based operations, were found to have greater prevalence of current and chronic respiratory symptoms than a control population of rural non-farm dwelling individuals ($p < 0.05$). Both the poultry workers and the grain farmers had lower lung function values compared to control subjects.

There is a range of lung diseases which result from occupational exposures in agriculture. Some toxic exposures on the farm include "organic dusts, infectious agents (bacteria, fungi, viruses, mycobacterium), endotoxins and glucans, toxic chemicals, pesticides, gases from silos, welding and animal waste, inorganic dusts, fertilizers and feed additives.[57] A study by Melbostad et al. of 8,483 Norwegian farmers and their spouses found the adjusted odds ratio for current asthma with animal production to be significant (OR=2.2, 95% CI: 1.1-4.2).[58] Current asthma was associated with animal production after adjusting for a positive family history of asthma and for smoking (OR=8.1, 95% CI: 4.0-16.2).

Senthilselvan et al. in a study of 1,634 adults ages 20 to 65 from Saskatchewan found grain farming to be a significant predictor of asthma (OR=1.7, 95%CI: 1.3-2.4).[17] A 15 year longitudinal study of Canadian grain elevator workers by Pahwa et al. found an increasing decline in FEV_1 and FVC increased according to length of time in the grain industry among all grain workers regardless of smoking status.[19] A study by Omland et al. of 1,901 young farmers under age 26 in Denmark in 1999, examined the effect of farming exposure on asthma-like symptoms and lung function. FEV_1 was significantly lower in male farmers ($p < 0.01$) compared to male controls. Working with cattle was significantly associated with reduced lung function in the male controls ($p < 0.05$).[59]

A Saskatchewan-based study determined the prevalence of asthma and respiratory symptoms in a farming population of Hutterite and non-Hutterite children. Parents of 830 school age farm dwelling children (ages 6-12), including 83 Hutterite children who lived on farming colonies, were given a questionnaire designed to identify respiratory symptoms, including asthma, and environmental factors, including exposure to farming activities in their children.[22] There was significantly less asthma in the Hutterite group (2.4%) compared to the other farming group (9.2%). The study could not determine if differences between the groups were due to differences in home environmental characteristics or in farming exposure, as Hutterite children participated less in farming activities than their non-Hutterite counterparts. Although children in both groups were reported to have a similar prevalence of allergy, they differed on exposure to farming activities and household exposures such as cigarette smoke. When looking at specific farming activities, Hutterite children did not differ from non-Hutterite children for feeding livestock or poultry, cleaning/playing in barns, moving/playing with bales or cleaning pens. However, they did differ for harvesting, emptying/filling grain bins, haying and grooming/playing with animals. This study did not explore the relationship between lung function and farming activities.

A study by Rennie found no difference between farm and acreage living location and non-rural locations in the prevalence of asthma or wheeze for 2,374 children who participated in a cross-sectional study of respiratory disease in rural central Saskatchewan.[29] Within this study, Rennie identified that increased wheeze was associated with participation in farming activities on a regular basis in children who lived on farms or acreages only.

A number of international studies have looked at the relationship between children with farming exposures and atopy; however, few have examined the relationship with asthma. Table 2-2 presents studies that have examined the association between specific farming exposures in children and asthma. All studies reported were published between 2000 and 2007. Many of the studies were conducted with European populations fewer studies were conducted with North American populations.

Ege et al. in 2007 conducted a cross-sectional study of 8,268 school age children ages 5 to 13 in 5 European countries. Information on farm-related exposures and health outcomes was obtained using questionnaires.[60] An inverse relationship was found between asthma and pig keeping (OR=0.77, 95% CI: 0.38-0.86), between asthma and frequent stay in animal sheds (OR=0.71, 95% CI: 0.54-0.95) and with child's

Table 2-2 Recent studies examining the association of asthma and respiratory symptoms with farming exposures

Study	**Year***	**Country**	**Age**	**Design**	**n**	**Definition of Asthma**	**Farming Exposure**	**Association OR (95% CI)**
Ege et al[60]	2007	Europe	5-13	CS	8263	Dr. dx or one episode obstructive bronchitis	Pig keeping, animal sheds, haying, use of silage	Pig keeping 0.77 (0.38-0.86)↓ Animal sheds 0.71 (0.54-0.95)↓ Haying 0.56 (0.38-0.81)↑
Wickens et al[25]	2002	New Zealand	7-10	CS	293	Parent report asthma	Place of residence, exposure to animals	First year of life exposure to poultry 2.7 (0.9-7.7) current regular exposure to poultry 0.8 (0.3-2.0) Beef cattle farming with wheeze 0.2 (0.1-1.00) dairy farming with asthma 0.3 (0.1-1.1) and wheeze 0.2 (0.1-0.9)↓
Riedler et al[24]	2001	Austria, Germany, Switzerland	6-13	CS	2618	Parent report of Dr. dx asthma	Childhood farm environment	First year of life exposure to stables and farm milk consumption 0.14 (0.04-0.48) ↓ compared with the same exposure in ages 1-5 0.88 (0.42-1.86)
Riedler et al.[23]	2000	Austria	8-11	CS	2283	Dr. dx	Live on farm Regular contact with livestock/poultry	Regular contact with livestock or poultry with allergic sensitization 0.48 (0.30-0.75)↓
von Ehrenstein et al[61]	2000	Germany	5-7	CS	10163	Dr. dx	Live on a farm, livestock on farm	Decreased atopic disease with increased livestock exposure 0.41 (0.23-0.74)↓

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Merchant et al[51]	2005	US	Birth-17	C	644	Dr. dx and/or medication for wheeze in the last 12 months	Add antibiotics to feed and raise swine.	For asthma 2.47 (1.29-4.74)↑
Salam et al[50]	2004	US	8-18	CC	4244	Dr. dx	Crops, dusts, animals, pesticides, herbicides	Ever exposed: Farm animals, farm crops, dust/asthma 1.9 (1.01-2.52)↑ First year of life herbicide or pesticide exposure/asthma 4.58 (1.36-15.43), 2.39 (1.17-4.89)↑

*=year published; CI= confidence interval; C=cohort; CS=cross-sectional; CC= case control; dx= diagnosis; AHR=airway hyper-responsiveness; NS= Not significant

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involvement in haying (OR=0.56, 95% CI: 0.38-0.81).

A study by Wickens et al. of 293 New Zealand farm children ages 7 to 10 found children in this study who currently live on farms have more asthma and wheeze. Increased asthma was associated with first year of life exposure to poultry (OR=2.7, 95% CI: 0.9-7.7) while current regular exposure to poultry was associated with less asthma (OR=0.8, 95% CI: 0.3-2.0).[25] Beef cattle farming was inversely associated with wheeze (OR=0.2, 95% CI: 0.1-1.00) and dairy farming was inversely associated with both asthma (OR=0.3, 95% CI: 0.1-1.1) and wheeze (OR=0.2, 95% CI: 0.1-0.9).

Riedler et al. conducted a cross-sectional survey in rural areas of Austria, Germany and Switzerland in 2001 of 3,504 parents of 6 to 13 year old children.[24] There was a lower frequency of asthma in farm children who were exposed to stables or drank farm milk in the first year of life (1.0%) compared to children who had the same exposures after the first year of life (11.0%). They also found that long term exposure to stables until age 5 was associated with the lowest frequency of asthma.

Riedler et al. in a 2000 study found less asthma associated with farm living in Austrian 8 to 11 year olds, they also found an association between regular contact with farm animals (livestock and poultry) and reduced atopic sensitization (OR=0.48, 95% CI: 0.30-0.75).[23] Atopic diseases were defined as doctor's diagnosis of asthma and or hayfever and/or eczema.

Questionnaires were given to parents of 10,163 children ages 5 to 7 in two Bavarian districts by von Ehrenstein et al. in 2000.[61] Increasing exposure to livestock among farmers' children was related to a decreased prevalence of atopic diseases (OR=0.41, 95% CI: 0.23-0.74).

A cohort study by Merchant et al. in 2005 conducted a study with children birth through 17 years of age in Iowa.[51] Merchant et al. found that asthma was associated with children who live on a farm that raised swine (OR=1.88, 95% CI: 1.02-3.45) and the level of risk increased when children live on a farm that raised swine and added antibiotic to animal feed (OR=2.47, 95% CI: 1.29-4.74).

Salam et al. found, in their study of 4,244 8 to 18 year old Californian children, that children who were exposed to pesticides (OR=2.39, 95% CI: 1.17-4.89) and herbicides (OR=4.58, 95% CI: 1.36-15.43) during their first year of life, were at higher risk of developing asthma.[50] Salam et al. also found that children who were ever exposed to farm animals, farm crops and dust had a higher risk of asthma than children without those exposures (OR=1.88, 95% CI: 1.28-4.59).

In summary, most studies have shown a negative association for asthma in children with farming exposures that are related to livestock keeping. However, exposure to pesticides and grain production could be associated with increased asthma or respiratory symptoms in children.

2.5 Lung Function and Asthma

As mentioned previously, asthma is a chronic lung disease characterized by recurrent cough and wheeze and intermittent airflow limitation.[30,62] Lung function is one objective measure that can be used to aid in the assessment of asthma.[63] These measurements are useful to establishing a diagnosis of asthma as well as providing objective information on severity of disease.[64,65] According to the Canadian Consensus Guidelines for asthma (CCG) FEV_1 values can be used to ascertain the level of disease severity. Children with mild to moderate asthma or those in periods of disease stability tend to have near normal pulmonary function values for their age and sex between exacerbations of their condition.[66] The FEV_1/FVC ratio is a better measure of asthma severity or obstruction.[64] A normal ratio is 86%. Values below 80% indicate airflow obstruction.[64] FEF_{25-75} provides greater sensitivity to lung function impairment in childhood asthma than FEV_1.[67] During a mild episode of asthma there can be a reduction in FEF_{25-75} and FEV_1.[35]

Asthma and respiratory symptoms have been associated with lowered lung function in children. Weiss et al. in a population based cohort study in Massachusetts of 602 children, initially ages 5 to 9, observed prospectively for 13 years, showed lowered FEF_{25-75} in subjects with active asthma compared to children with no history of asthma.[68] Conversely, a German study by Droste et al. of 402 school children age 7 and 8 years found lower lung function in children who wheezed compared to those who did not.[69] However, the lung function values for children with and without asthma showed no differences. A study by Lawson et al. of 641 rural students in Grades 1 to 4 from Estevan, Saskatchewan suggested that children with asthma have lower lung function than their peers with wheeze.[63] From the same study population as Lawson et al., a study by Rennie et al. compared lung function values in Grades 1 to 6 children in two Saskatchewan communities and found that children with a doctor diagnosis of asthma or with reported wheeze had lower lung function values than asymptomatic children in both communities.[8]

Studies examining lung function in farming populations of children could not be located. Studies with adult populations have shown decreased lung function. A longitudinal study by Senthilselvan et al. in 2000 on 200 adults in Southwestern Saskatchewan found seasonal changes in lung function measurements between winter and summer.[70] Mean percentage changes in FEV_1/FVC showed an improvement for town residents who were not engaged in farming and increasing declines for town residents engaged in farming, farm residents not engaged in farming and farm residents engaged in farming. The differences in FEV_1/FVC between town/non-farmer and farm-resident farmer group were significant ($p < 0.01$). A longitudinal study of Canadian grain workers by Punam et al. found the estimated annual decline in FEV_1 and FVC increased according to length of time in the grain industry.[19] A cross-sectional study of grain workers, poultry workers, and non-farming controls by Kirychuk et al. found grain farmers to have lower FVC and FEV_1 than non-farmers.[20] Subjects who worked in cage based poultry operations had lower mean values for $FEV_{1,}$ $FEF_{25\text{-}75}$ and FEV_1/FVC than subjects who worked in floor base poultry operations. Subjects that worked with cage based poultry had significantly lower $FEF_{25\text{-}75}$ and FEV_1/FVC than non-farming controls ($p < 0.05$).

There are many factors which can affect lung function test results. Incorrect test performance and interpreting the results inaccurately increases the risk of misclassification (false negative or false positive lung function abnormality or lung function change).[71] Factors that can affect lung function results include sex, age, height, weight, race/ethnicity, socioeconomic and environmental characteristics as well as body position (sit/stand) and effort during the test, medications or disease conditions that may affect lung function subject preparation and equipment used.[63,71,72] Guidelines are provided for the performance of lung function testing and adjustments in analyses are made based on these factors to ensure the lung function measures are accurate, repeatable and reproducible.[72,73]

2.6 Summary

Asthma is a respiratory disease that affects approximately 15% of Canadian children, making it the most common chronic disease in childhood. Some studies have shown the farming environment to be protective for asthma and respiratory symptoms in children particularly if the exposure is in the first year of life. Other studies, primarily with adult populations, have shown the farming environment to be associated with increased asthma and respiratory symptoms, particularly if those adults were grain farmers or worked with poultry or in animal production. There are limited Canadian studies of the association between farming activities and asthma and respiratory symptoms in children. There has been some study of how some specific farming environments affect respiratory symptoms and asthma in children. Early exposure to livestock in the farming environment has been shown to be protective for the later development of atopy and asthma. However, the effect of current farming exposures for asthma and/or respiratory symptoms is less clear as studies have identified both increased and decreased risks for asthma. Previous studies examining farming activities and their association with respiratory symptoms or disease have not identified the role of lung function.

2.7 Research Questions

Based on a review of the literature and the data available through the children's questionnaire in the Humboldt study, the specific research questions to be addressed by this study are:

1. What is the prevalence of asthma and respiratory symptoms in school age children overall and according to home location (i.e. living in town or living on a farm)?
2. Is there an association between the exposures to selected farm related activities and asthma or respiratory symptoms in a group of school age children?
3. Is there an association between participation in selected farm related activities and lung function values in school age children?

2.8 Significance of the Study

This study could potentially advance our understanding of the relationship between specific farming environments and asthma and respiratory symptoms in a rural Canadian population. An objective clinical measurement of lung function values could provide useful information about the severity of childhood asthma and respiratory symptoms associated with bystander participation in farming activities by children. This is one of a few studies to have examined the relationship of lung function and farming activities in children as well as the relationship between specific farming environments and asthma and respiratory symptoms of cough, wheeze, and/or phlegm in children.

Chapter 3: Methodology

3.1 Study Location

Humboldt is an agricultural community located about 100 km from a major urban center in Saskatchewan. The population of Humboldt in 2003 was 5,600. It is a major service centre and has been the site for three previous surveys of respiratory health conducted in 1977, 1983 and 1993.

In 2003 a study of respiratory health of the residents of Humboldt, Saskatchewan and surrounding rural municipality was conducted. Children between the ages of 6 and 18 participated in the cross-sectional survey questionnaire and lung function measurement. The study was conducted by researchers at The Canadian Centre for Health and Safety in Agriculture (CCHSA), University of Saskatchewan with Dr. J. Dosman as principal investigator. Data obtained included information on asthma, respiratory symptoms and exposure to household and various farming activities for children.

3.2 Collected Data

3.2.1 Collection Strategies

The design for the Humboldt Study consisted of a population based cross-sectional survey of all individuals ages 6 to 79 years living in Humboldt and the surrounding rural municipalities. There were two major collection strategies used, a parent self-administered questionnaire and, following consent, a health assessment of the child that included lung function, skin prick testing (SPT) for atopy, and buccal swabs for genotyping of DNA. A letter accompanied the questionnaire which explained the study procedures. The parent most familiar with the child's health was asked to complete the questionnaire and sign a consent for assessment of atopy by skin testing, collection of buccal smears for genetic studies, and measurement of blood pressure and lung function. Written consent from the child was also obtained (See Appendix A for consent form and letter to parents). Ethics approval was obtained from the University of Saskatchewan (see Appendix B) as well as approval for the children portion of this study from the local public and separate school boards and school principals.

3.2.2 Respiratory Questionnaire

In 2004, questionnaires were distributed through the three participating elementary schools to 636 students to be completed by a parent and returned through the schools to the researchers. The questionnaire used for the study (see Appendix C) was based on the 1979 Children's Respiratory Questionnaire of the American Thoracic Society (ATS) and the previous questionnaire used in the 1993 Humboldt study of children.[29,74] The questionnaires provided information on demographics, current and past cough, phlegm/congestion, wheeze, history of asthma, medication use, history of respiratory illness (e.g. bronchitis, pneumonia, etc.), history of allergy, past illnesses (e.g. diabetes, heart disease, etc.), history of hospitalization, lifestyle factors (e.g. physical activity), information regarding general environment (e.g. home location, farm visits, etc.), household environment [e.g. mold in home and exposure to (ETS)], farming activities of children ,and family history of diseases such as asthma and diabetes.

3.2.3 Health Assessment

The health assessment included objective measurements of height, weight, blood pressure, skin prick test for atopy, buccal smear for genetic testing, and lung function. Lung function, height and weight measurements, and assessment of atopic status (indicator of allergic status) are described in more detail below. Genetic testing and blood pressure were not used in this analysis. Both parental consent and child consent were required for spirometry and other measurements. Children could refuse to participate at anytime prior to or during assessment. All health assessments for children included in this analysis were conducted at the three participating elementary schools.

3.2.4 Measurement of Atopy

Atopy, a measurement of allergic status, was determined by a skin prick test using a standard technique to a panel of 6 allergens, *Dermatophagoides pteronyssinus* (house dust mite), *Dermatophagoides farinae* (house dust mite)**,** *Alternaria alternate* (fungus)**,** *Alternaria Cladosporium* (fungi), *Feline Domestica* (cat allergen) and mixed grasses containing a mixture of common grasses found on the prairies, along with positive histamine and negative saline control. The reaction was regarded as positive if the diameter of the skin wheal after 15 minutes of testing was 3 millimeters or more greater than the negative control (saline).

3.2.5 Lung Function, Height and Weight

Lung function testing was carried out using two MedGraphics CPF-S Systems (Medical Graphics Corporation, St. Paul's MN), which followed the Standardization of Spirometry recommended in 1993 by the ATS.[67] Spirometry assessment was based on the ATS guidelines for spirometry for children.[67] Nurses trained in spirometry conducted the testing during regular school hours. Each subject was tested until three acceptable forced expiratory maneuvers were obtained or to the maximum of 5 efforts. The standard for choosing FVC, FEV_1, and FEF_{25-75} were: 1) the best FVC and FEV_1, not necessarily from the same tracing and 2) the FEF_{25-75} which came from the tracing with the best sum of FVC and FEV_1. The FEV_1/FVC ratio was also determined.

Weight was measured to the nearest 0.5 kg using a calibrated hospital spring scale with subjects dressed in normal indoor clothing. Height in centimetres was measured against a wall, using a wall-mounted tape measure and a fixed square. Subjects did not wear shoes for weight and height measurements.

3.2.6 Operational Definitions

The following operational definitions were used for this study:

Dependent Variables

Asthma: A positive parental response to either question; "During the past 12 months has a doctor ever said you have asthma?" or "Before the past 12 months has a doctor ever said you have asthma?" These questions have been used in previous studies of asthma, [29,32,43,63] have shown good agreement with physical examination (Kappa=0.79),[76] and have shown good reliability on repeat reporting by parents.[29,75,76]

Current Asthma: A positive parental response to, "During the past 12 months has a doctor ever said you have asthma?" as well as positive responses to any of the following questions; "During the past 12 months how many times has the child required services for asthma from an emergency department?" or "During the past 12 months how many times has the child required services for asthma from a doctor's office?" or "Which of the following statements best describes this child's asthma medication use in the past 12 months; at least once per month, at least once per week or everyday?" An answer of 1 or more visits to the emergency room or doctor's office for asthma, or use of medication for asthma in the past 12 months was indicative of current asthma.

Respiratory Symptoms: A positive parental response to at least one of the following; "Does this child usually have a cough?" or "Does this child chest ever sound wheezy or whistling when the child has a cold?" or "Does this child chest ever sound wheezy or whistling not associated with a cold?" or "Does this child usually have congestion in the chest or bring up phlegm with cold?" or "Does this child usually have congestion in the chest or bring up phlegm other than with cold?"

Independent Variables

Early Farm Exposure: Positive parental response to the following "in the first 12 months of this child's life did this child live on a farm or visit a farm more than three times?"

ETS Exposure: Exposure to passive smoke was identified by presence or absence of cigarette, cigar or pipe smoking in the home by family members.

Farming Activities: Parents indicated exposure (yes/no) to each one of seven selected farming activities by the question, "In the past 12 months has this child spent more than

1 hour on a regular basis near any of the following activities?” Individual activities assessed were; haying, harvesting**,** moving or playing with hay bales, feeding livestock, cleaning or playing in barns, cleaning pens, and emptying or filling grain bins.

History of Breastfeeding: Determined by a positive response to the question “Was this child breastfed?”

Home Dampness: Determined by a positive response to, “Does your home have any damage caused by dampness?” and/or “Are there signs of mold or mildew in any of the living areas of your home?”

Home Heating: “How the home was heated in the winter (gas furnace or other)?”

Home Location: Determined by the question, “Where is your home located, farm/acreage/in town?” A response of either “farm” or “acreage” resulted in classification of residence as farm, while a positive response to “in town” resulted in a non-farm classification of residence.

Hospitalizations in the Last 12 Months: Defined as a positive parental response to: “During the past 12 months was this child kept over night in hospital for any illness?”

Parental (Mother or Father’s) History of Allergy: Determined by positive response to, “Has the biological mother of this child had asthma, allergy or hay fever?” or “Has the biological father of this child had asthma, allergy or hay fever?”

Pets in the Home: Determined by presence of dog(s), cat(s) or bird(s) in the home and also if, during the child's lifetime there had ever been a dog, cat or bird living in the home.

Previous Respiratory Illness: Positive parental response to: "During the past 12 months has a doctor ever said this child has had any of the following chest illness: bronchitis, pneumonia, croup, other chest illness?"

3.3 Data Analysis

3.3.1 Inclusion and Exclusion of Subjects

All children attending Grades 1 to 8 from the three elementary schools in Humboldt were eligible for this analysis (n=636). The response rate for children in Grades 1 to 8 was 86.9%. High school students were excluded because the low response rate (67%) in that group. All potential subjects were invited to complete pulmonary function testing during school hours.

3.3.2 Sample Size Calculation for the Association between Asthma, Respiratory Symptoms and Farming Activities

The outcomes of interest for this sample size calculation are asthma and respiratory symptoms. The exposure of interest is participation in farming activities, based on a dichotomous variable of participation or not. The adequacy of the sample size for this analysis was determined by comparing the participating sample size with the required sample size based on the following formula [77]:

$$n = \frac{2pq(Z_{\alpha} + Z_{\beta})^2}{(p_1 - p_0)^2} \tag{3.1}$$

where: $p = \frac{p_1 + p_0}{2}$

$q = 1 - p$

$p_1 = \frac{p_0 R}{[1 + p_0(R - 1)]}$

and where:

p_0 = estimates exposure rate to farming activities = 0.31%

R = relative risk = 2.0

α = level of significance used to detect an association = 0.05

β = Type II error: probability of not detecting a significant association when one actually exists = 0.20

$1-\beta$ = Type I error: the degree of certainty that the association if present, would be detected = 0.8

Z_{α} = 1.96

Z_{β} = 0.842

In a previous study of farming exposures in Humboldt children there were 31% children who were exposed to farming activities. An odds ratio of 2.0 would be considered to suggest a clinically meaningful relationship between farming activities and asthma or respiratory symptoms. A significance level, α of 0.05 and β= 0.20 resulting in a power of 0.80 to detect an association if one exists. Based on this information a sample size of 139 is required in each of the farming and non-farming groups. In the current study there are 180 children living on a farm and 372 children in the non-farming group so group size is adequate to find a significant association if one exists.

3.3.3 Sample Size Calculation to Test Associations between Lung Function and Farming Activities

Based on a previous study in Humboldt where mean FEV_1 was 2.6 L ($\pm$0.51 L) in a group of children aged 8 to 12 [43] and using the formula: [78,79]

$$n = 2(Z_\alpha + Z_\beta)^2 \sigma^2 / d^2 \qquad (3.2)$$

the sample size required to detect a 0.26 L (d=0.1) difference in FEV_1 between groups can be calculated.[78] Based on 80% power ($\beta = 0.2$ and Z_β=0.842) with α =0.05 and Z_α =1.96, a minimum of 408 children were needed for the study. As 530 children completed spirometry successfully in this study, the sample size appears adequate for this analysis.

3.3.4 Data Entry

Data was double entered by research assistants using Filemaker Pro 6.0 Version 4 and then the data was transferred to the Statistical Package for Social Sciences Version 14.0 (SPSS 14.0) at CCHSA, University of Saskatchewan. The data was cleaned using frequencies, contingency tables and by checking and correcting using the original questionnaires. All personal identifiers were removed prior to student analyses.

3.3.5 Methods of Analysis

The types of statistical analyses conducted, by research question, are described below.

3.3.5.1 Research Question #1

The overall prevalence of asthma was determined by dividing the number of positive responses to any doctor diagnosed asthma by the total eligible study population and multiplying by 100 to get percent prevalence. The overall prevalence of respiratory symptoms was determined by dividing the number of positive responses to respiratory symptoms by the total eligible study population and multiplying by 100 to get percent prevalence. The total eligible population was then stratified by home location to provide separate prevalence estimates of asthma and respiratory symptoms for children living in town compared to those living on farms. For both asthma and respiratory symptoms comparisons by home location were tested using chi-square tests. The concordance between asthma and respiratory symptoms was assessed by Kappa statistic.

3.3.5.2 Research Question #2

As it is highly likely more that one farming activity could occur simultaneously in the farming environment of the child (i.e. haying, moving or playing with hay bales and harvesting) Intercorrelations between the 7 farming variables were determined using the Spearman rank statistical test.[80] The 7 farming activities were found to be statistically significantly correlated, and their associations with asthma, respiratory symptoms and lung function were assessed individually. Bivariate analyses were used to assess for potential risk factors using χ^2 test for proportions or t-test for independent means for continuous data. Multiple logistic regression models were used to assess associations between asthma or respiratory symptoms and farming activities adjusting for the potential risk factors (demographic and environmental).[81] All variables with a p of < 0.25 in the bivariate, as well as the clinically important variables were included in the multivariable analysis.[78,79]

3.3.5.3 Research Question #3

Only subjects with acceptable lung function were included in this analysis. All other children (no consent or lung function reports where the FEV_1/FVC ratio was 1.00) were combined and compared with the acceptable lung function group. The two groups of subjects were compared on demographic and health related variables using χ^2 testing and t-tests for independent means. As there were known differences for pulmonary function based on age sex and height in children, all analyses assessing differences in pulmonary function measures (FEV_1, FVC, FEV_1 /FVC ratio, FEF_{25-75}) between those who participated in farm related activities and those who did not were adjusted for these variables. Because lung function is a continuous variable multiple linear regression models were used to test the association between lung function variables and individual farming activities.[79, 81] Separate multiple regressions were conducted to assess associations between lung function variables and respiratory symptoms and lung function variables and asthma. Models were adjusted for height, weight and age.

Chapter 4: Results

4.1 Study Population

4.1.1 Inclusions/Exclusions and Response Rate

The eligible population for this analysis included 636 children in Grades 1 to 8 from three elementary schools in the city of Humboldt. There were 553 subjects with adequate questionnaire data resulting in a response rate of 86.9%. Figure 4-1 shows the distribution of participants and non-participants. There were 8 subjects who refused lung function testing or who did not provide consent on the day of testing and 13 who had unacceptable lung function. Of those subjects participating in the study lung function was available for 532 subjects.

The study population was evenly distributed with regards to sex, with 268 (48.5%) boys and 285 (51.5%) girls participating. The mean age (± standard deviation) of the eligible population was 9.86 [±2.30 standard deviation (SD)] years.

4.2 Prevalence of Asthma and Respiratory Symptoms according to Home Location

Research question #1: *"What is the prevalence of asthma and respiratory symptoms in school age children overall and according to home location (i.e. living in town or living on a farm)?"* There were 104 subjects in this study who reported ever having a doctor's diagnosis of asthma resulting in an overall prevalence of 18.8%

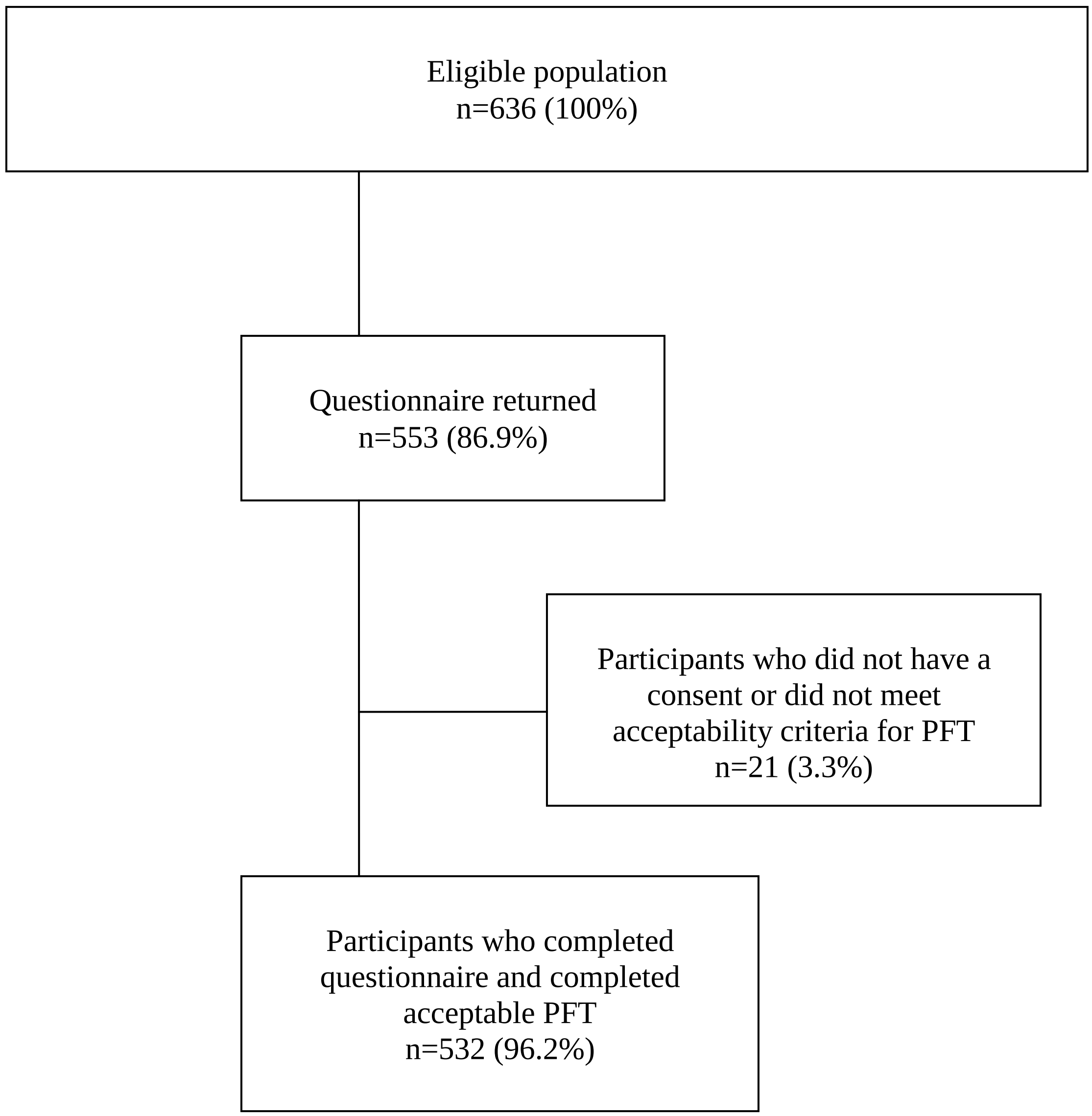

FIGURE 4-1 Distribution of participants and non-participants in the eligible study population

(95% CI: 18.1%-20.7%). There were 62 subjects who reported having a doctor's diagnosis of asthma in the past 12 months resulting in a current asthma prevalence of 11.2% (95% CI: 10.9%-12.6%). There were 220 subjects who reported respiratory symptoms for an overall prevalence of 39.8% (95% CI: 39.2%-41.1%).

4.3 Associations between Asthma, Respiratory Symptoms and Lung Function Variables

When the concordance between asthma and respiratory symptoms was assessed, most of the children with asthma reported respiratory symptoms (76.9%; $p < 0.001$) while only 36.4% of children with respiratory symptoms had asthma (Kappa = 0.32). When the associations between lung function variables and asthma and respiratory symptoms were assessed, asthma was associated with a decrease in $FEF_{25\text{-}75}$ and FEV_1/FVC, while respiratory symptoms were associated with an increase in FVC (Table 4-1).

Differences in children with and without asthma were examined by home location. Similarly, differences in children with and without respiratory symptoms were also examined by home location. Figure 4-2 shows the proportion of subjects in each of the outcome groups (asthma and respiratory symptoms) stratified by home location. The prevalence of asthma and respiratory symptoms are fairly evenly distributed between subjects who live on a farm and those who live in town. There was a slight difference noted in the prevalence of asthma between children who lived on farms/acreages

Table 4-1 Associations between lung function variables and asthma and between lung function variables and respiratory symptoms (n=531)*

Lung Function Measurements		Asthma			Respiratory Symptoms		
		Beta	S.E	p value	Beta	S.E	p value
Model 1	FEV_1	-0.012	0.035	0.74	0.033	0.028	0.25
Model 2	FVC	-0.044	0.037	0.24	**0.062**	**0.030**	**0.04**
Model 3	$FEF_{25\text{-}75}$	**-0.154**	**0.071**	**0.03**	-0.020	0.058	0.73
Model 4	FEV_1/FVC	**-0.019**	**0.008**	**0.01**	-0.009	0.006	0.15

* All analyses were adjusted for age, sex and height

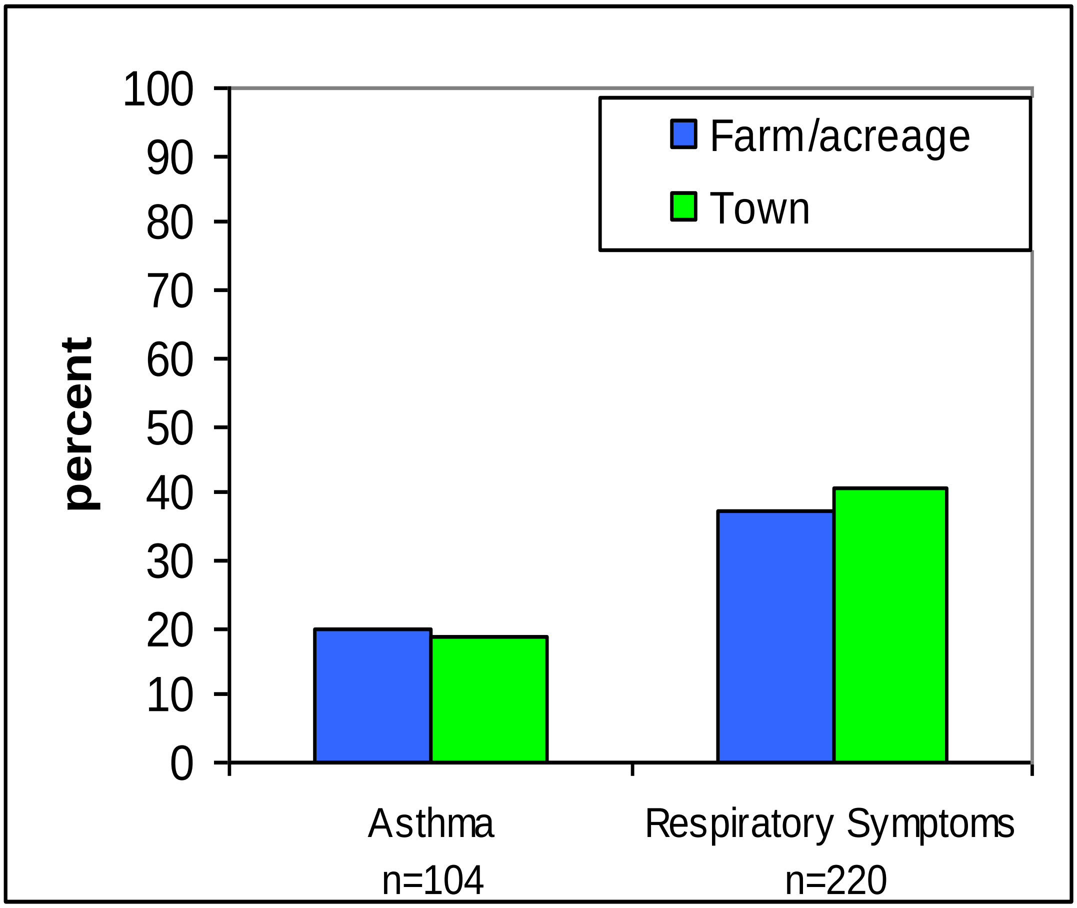

Figure 4-2 Proportion of the study population (n=553) classified as having asthma or respiratory symptoms by home location

(20.0%) compared to children who live in town (18.5%), but this difference was not statistically significant (χ^2=0.14, df=1; p =0.71). Respiratory symptoms were slightly higher in children living in town (40.4%) compared to children who lived on farms (37.4%) but again this difference was not statistically significant (χ^2=0.35, df=1, p=0.56). Subjects who lived in towns were significantly older than subjects living on farms.

4.4 Farming Activities

Research question #2: "*Is there an association between the exposures to selected farm related activities and asthma or respiratory symptoms in a group of school age children?* Prior to assessing associations between farming activities and asthma or respiratory symptoms, the associations between reported risk factors for asthma, including host and environmental characteristics, were assessed.

4.4.1 Bivariate Analyses

Table 4-2 presents the findings of the risk factors and host characteristics for asthma for children with or without asthma and for the study population overall. Approximately one quarter (23.8%) of the study population was atopic, 16.6% of the population was exposed to passive smoking (by parents or family members in the home), over three quarters of the study population had been breastfed, most did not live in damp housing and most lived in a single family home that was heated by gas. There were no significant differences between groups for farm exposure in the first 12 months of life and current pet.

Table 4-2 Distribution of host risk factors for asthma (n=553)

	Asthma (n=104) n (%)	No asthma (n=449) n (%)	Overall (n=553) n (%)
Age (years)	Mean (SD) 9.77 (± 2.20)	Mean (SD) 9.88 (± 2.33)	Mean (SD) 9.86 (± 2.30)
Sex			
Male	61 (58.7)*	207 (46.1)	268 (48.5)
Female	43 (41.3)	242 (53.9)	285 (51.5)
Atopy†			
No	61 (62.9)	333 (79.2)	394 (76.7)
Yes	34 (37.1)‡	82 (20.1)	116 (23.3)
Breastfed			
No	31 (29.8)	87 (19.4)	118 (21.3)
Yes	73 (70.2)	362 (80.6)*	435 (78.7)
Current Pet			
No	57 (54.8)	251 (55.9)	308 (55.7)
Yes	47 (45.2)	198 (44.1)	245 (44.3)
Damp Housing			
No	75 (72.1)	354 (78.8)	429 (77.6)
Yes	29 (27.9)	95 (21.2)	124 (22.4)
Farm Exposure 1st 12 months of life			
No	34 (32.7)	189 (39.7)	223 (40.3)
Yes	70 (67.3)	260 (60.3)	330 (59.7)
Heat			
No	30 (28.8)	91 (20.3)	121 (21.9)
Gas	74 (71.2)	358 (79.7)	432 (78.1)
Parental history of allergy			
No	36 (34.6)	250 (55.7)	286 (51.7)
Yes	68 (65.4)§	199 (44.3)	267 (48.3)
Passive smoking			
No	83 (79.8)	378 (84.2)	461 (83.4)
Yes	21 (20.2)	71 (15.8)	92 (16.6)
Type of Home			
Other	12 (11.5)	36 (8.0)	48 (8.7)
Single Family	92 (88.5)	413 (92.0)	505 (91.3)

* $p < 0.05$
† Atopy n=514
‡ $p < 0.01$
§ $p < 0.001$

The prevalence of asthma was higher in boys than in girls ($p < 0.05$). Children with asthma were more likely to be atopic ($p < 0.01$). Subjects who were breastfed were less likely to be asthmatic. Parental history of allergy was associated with having asthma as well ($p < 0.001$). Passive smoking, farm exposure in the first 12 months of life, damp housing, type of home, gas heat, and current pet were not associated with asthma. There were no significant differences in age between children with asthma (9.77 ± 2.20) compared with children without asthma (9.88 ± 2.33 SD).

Table 4-3 presents the findings of the risk factors and host characteristics for children with or without respiratory symptoms and for the study population overall. There was no difference in age between the children in the no respiratory symptoms group compared with the children who had respiratory symptoms. If the subjects were male, they were more likely to have respiratory symptoms. Parental history of allergy was associated with respiratory symptoms. Children with respiratory symptoms were significantly more likely to live in damp housing and also were significantly more likely to live in a dwelling other than a single family dwelling. There were no significant associations between respiratory symptoms and being atopic, being breastfed, exposure to farming in the first 12 months of life, farm type, gas heat, or having a current pet.

4.4.2 Farming Activities and Asthma and Respiratory Symptoms

Figure 4-3 shows the proportion of study subjects participating in 7 different farming activities. A history of farming activities of at least one hour at a time in the past year was reported by 183 subjects (33.1%). The farming activity with the least participation was cleaning pens (3.8%) while the greatest number of subjects

Table 4-3 Distribution of host risk factors by respiratory symptoms (n=553)

	Respiratory Symptoms (n=220) n (%)	No Respiratory Symptoms (n=333) n (%)	Overall (n=553) n (%)
Age (years)	Mean (SD) 9.60 (± 2.26)	Mean (SD) 10.03 (± 2.32)	Mean (SD) 9.85 (±2.30)
Sex			
Male	121 (55.0)*	147 (44.1)	268 (48.5)
Female	99 (45.0)	186 (55.9)	285 (51.5)
Atopy †			
No	148 (70.8)	246 (80.7)	394 (76.7)
Yes	61 (29.2)	59 (19.3)	120 (23.3)
Breastfed			
No	54 (24.5)	64 (19.2)	118 (21.3)
Yes	166 (75.5)	269 (80.8)	435 (78.7)
Current Pet			
No	124 (56.4)	184 (55.3)	308 (55.7)
Yes	96 (43.6)	149 (49.7)	245 (44.3)
Damp Housing			
No	149 (67.7)	280 (84.1)	429 (77.6)
Yes	71 (32.3)‡	53 (15.9)	124 (22.4)
Farm Exposure 1st 12 months of life			
No	90 (40.9)	133 (39.9)	223 (40.3)
Yes	130 (59.1)	200 (60.1)	330 (59.7)
Heat			
No	51 (23.2)	70 (21.0)	121 (21.9)
Gas	169 (76.8)	263 (79.0)	432 (78.1)
Parental history of allergy			
No	88 (40.0)	198 (59.5)	286 (51.7)
Yes	132 (60.0)‡	135 (40.5)	267 (48.3)
Passive smoking			
No	172 (78.2)	289 (86.8)	461 (83.4)
Yes	48 (21.8)§	44 (13.2)	92 (16.6)
Type of Home			
Other	29 (13.2)§	19 (5.7)	48 (8.7)
Single Family	191 (86.8)	314 (94.3)	505 (91.3)

* $p < 0.05$
† Atopy n=514
‡ $p < 0.001$
§ $p < 0.01$

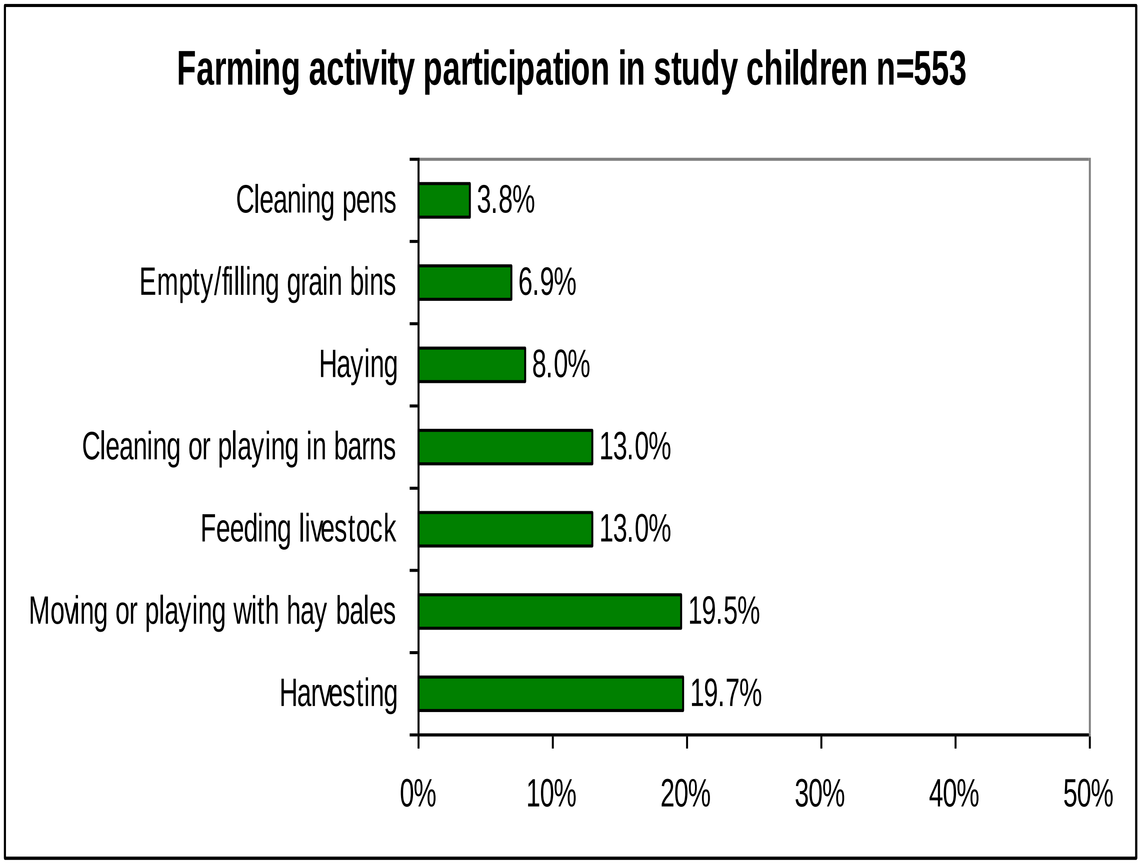

Figure 4-3 Farming activity participation in study children

participated in moving or playing with hay bales (19.5%) and in harvesting (19.7%).

Figure 4-4 shows the frequency of asthma and respiratory symptoms within the seven farming activities. Over 58% of children with respiratory symptoms were involved in moving or playing with hay bales followed by harvesting at 50%. Children with respiratory symptoms were least likely (just over 10%) to be involved in cleaning pens. Children with asthma were most likely to be involved in harvesting (approximately 28%) followed closely by moving playing in hay bales. Children with asthma were also least likely to be involved with cleaning pens at below 5%.

4.4.2.1 Test for Multicollinearity with Farming Activities

In order to assess the correlation between various farming activities prior to conducting a multivariable analysis that included significant covariates or clinically significant variables, Spearman rank correlation coefficients were computed for each possible pair of the farming activities, Table 4-4 shows these results in the form of a correlation matrix. Correlations ranged from 0.15 for cleaning/playing in barns by emptying and filling grain bins to 0.65 (feeding livestock by cleaning/playing in barns). The highest correlation was between feeding livestock and cleaning/playing in barns, followed by feeding livestock and moving/playing with hay bales. All results were significant ($p < 0.001$). Based on the Spearman correlation coefficient results there is a presence of multicollinearity and therefore each activity was assessed independently in the multivariable logistic regression analyses.

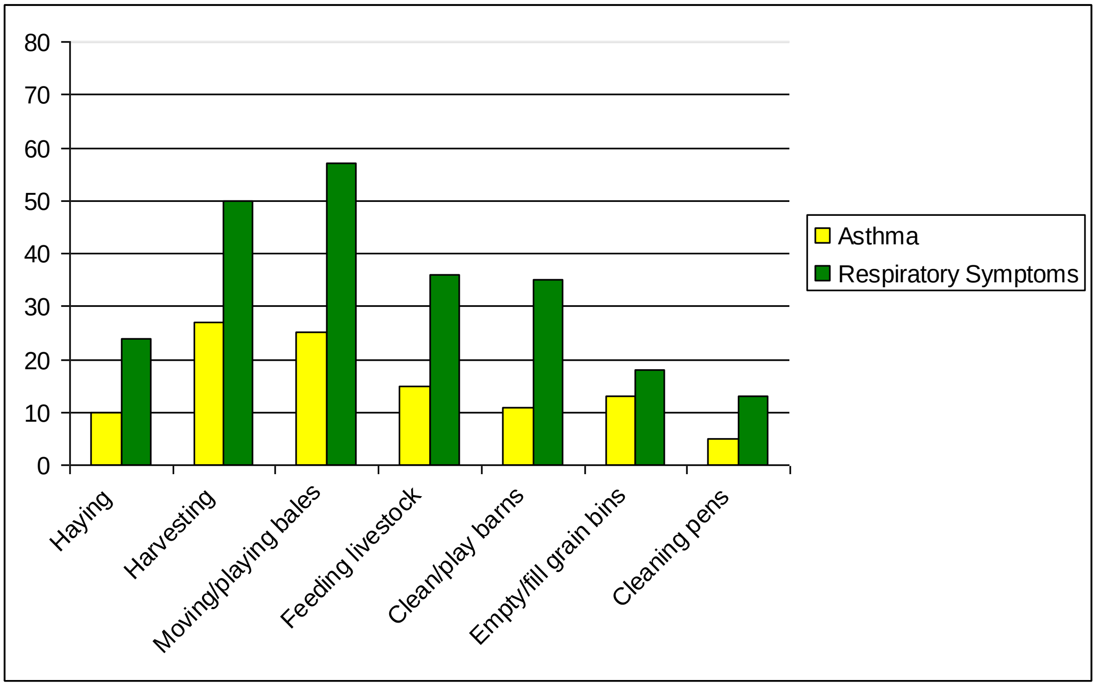

Figure 4-4 Participation in farming activities of children with asthma and respiratory symptoms

Table 4-4 Results of Spearman rank analysis comparing farming activities* (n=553)

	Haying	Harvesting	Hay bales	Feeding livestock	Cleaning/ playing in barns	Cleaning pens	Emptying/ filling grain bins
Haying	1.00	0.43	0.46	0.50	0.40	0.47	0.18
Harvesting		1.00	0.41	0.32	0.30	0.26	0.46
Moving /playing with hay bales			1.00	0.56	0.51	0.33	0.17
Feeding livestock				1.00	0.65	0.49	0.24
Cleaning or playing in barns					1.00	0.49	0.15
Cleaning pens						1.00	0.32

*All results significant at $p < 0.001$

At the bivariate level, exposure to grain bins was associated with more asthma in children ($p < 0.05$), respiratory symptoms were seen more often in children if they were exposed to haying ($p < 0.05$), moving or playing with hay bales ($p < 0.01$), and cleaning pens ($p < 0.05$). All of these associations appear to be quite strong as seen by the p-values and the 95% CI's for the unadjusted odds ratios.

Table 4-5 shows the frequency of exposures to the farming activity variables for children in the study with asthma compared to children with no asthma. Children with asthma were more likely to be emptying/filling grain bins compared to children without asthma ($p < 0.05$). Harvesting also shows a trend for asthma ($p < 0.10$).

Table 4-6 shows the frequency of exposures to the farming variables for children in the study with respiratory symptoms compared to children in the study with no respiratory symptoms. Children who participated in haying had increased respiratory symptoms compared to children who did not ($p < 0.05$). Children who participated in moving/playing with bales ($p < 0.01$) and cleaning pens ($p < 0.05$) also had increased respiratory symptoms compared to children who did not participate in those activities. There was a trend for increase in respiratory symptoms if children participated in feeding livestock ($p = 0.06$) and for cleaning/playing in barns ($p = 0.10$) compared to children who did not participate in those activities.

Full multivariable logistic regression analyses were conducted for each farming activity variable adjusting for risk factors significant at the univariate level or those deemed clinically significant from a review of the literature. In addition to each of seven

Table 4-5 Participation in farming activities by asthma no asthma status (n=553)

Farming Activity Variables	Asthma n=104 n (%)	No Asthma n=449 n (%)
Haying		
No	94 (90.4)	415 (92.4)
Yes	10 (9.6)	34 (7.6)
Harvesting		
No	77 (74.0)	367 (81.7)
Yes	27 (26.0)*	82 (18.3)
Hay bales		
No	79 (76.0)	366 (81.5)
Yes	25 (24.0)	83 (18.5)
Feeding livestock		
No	89 (85.6)	392 (87.3)
Yes	15 (14.4)	57 (12.7)
Barns		
No	93 (89.4)	388 (86.4)
Yes	11 (10.6)	61 (13.6)
Pens		
No	99 (95.2)	433 (96.4)
Yes	5 (4.8)	16 (3.6)
Grain bins		
No	91 (87.5)	424 (94.4)
Yes	13 (12.5)†	25 (5.6)

* $p < 0.10$
†$p < 0.05$

Table 4-6 Comparison of children with respiratory symptoms and children with no respiratory symptoms for participation in selected farming activities (n=553)

Farming Activity Variables	Respiratory Symptoms n= 220 n (%)	No Respiratory Symptoms n=333 n (%)
Haying		
No	196 (89.1)	313 (94.0)
Yes	24 (10.9)*	20 (6.0)
Harvesting		
No	170 (77.3)	274 (82.3)
Yes	50 (22.7)	59 (17.7)
Hay bales		
No	163 (74.1)	282 (84.7)
Yes	57 (25.9)†	51 (15.3)
Feeding livestock		
No	184 (83.6)	297 (89.2)
Yes	36 (16.4)	36 (10.8)
Barns		
No	185 (84.1)	296 (88.9)
Yes	35 (15.9)	37 (11.1)
Pens		
No	207 (94.1)	325 (97.6)
Yes	13 (5.9)*	8 (2.4)
Grain bins		
No	202 (91.8)	313 (94.0)
Yes	18 (8.2)	20 (6.0)

* $p < 0.05$
†$p < 0.01$

farming variables entered separately, each full regression model included age, sex, parental history of allergy, exposure to passive smoke in the home, dampness in the home, pets in the home and home heat. Results of the logistic regression for farming farming activities by asthma and respiratory symptoms are shown in Table 4-7.

Exposure to grain bins statistically significantly increased the risk of asthma two-fold in children ($p < 0.05$). Children also had a two fold increase for respiratory symptoms when exposed to haying ($p < 0.05$), an almost two fold increased risk for respiratory symptoms when moving or playing with hay bales ($p < 0.01$) and just over two and a half times more risk of respiratory symptoms when involved in cleaning pens ($p < 0.05$). After adjusting for risk factors, there was a two-fold increase in asthma with exposure to grain bins. Similarly, children exposed to haying were two times more likely to have respiratory symptoms and an almost two fold increase in risk of respiratory symptoms when exposed to moving or playing with hay bales. Children who were exposed to the cleaning of pens were two and a half times more likely to have respiratory symptoms. See Appendix D for the logistic regression analysis for each farming activity and asthma and respiratory symptoms.

4.5 Lung Function and Farming Activities

Research question #3: "*What is the association between participation in selected farm related activities and lung function values in school age children?*"

This component of the analysis compared differences in lung function measurements between those who participated in farm related activities and those who

Table 4-7 Results of logistic regressions for individual farming activities by a) asthma and by b) respiratory symptoms

Models	Farming activities	a) Asthma Adj OR[1] (95% CI)	b) Respiratory Symptoms Adj OR[1] (95% CI)
Model I	Haying (ref=no)	1.08 (0.50–2.36)	**2.08 (1.07–4.06)**
Model II	Harvesting (ref=no)	1.41 (0.83–2.38)	1.42 (0.90–2.25)
Model III	Hay bales (ref=no)	1.13 (0.65–1.96)	**1.89 (1.19–3.01)**
Model IV	Feeding livestock (ref=no)	1.05 (0.55–1.99)	1.70 (1.00–2.89)
Model V	Barns (ref=no)	0.73 (0.36–1.47)	1.60 (0.95–2.71)
Model VI	Cleaning pens (ref=no)	1.15 (0.39–3.39)	**2.70 (1.05–6.97)**
Model VII	Grain bins (ref=no)	**2.18 (1.03–4.62)**	1.35 (0.67–2.76)

[1]Adjusted for: age, sex, parental allergy, parental smoking, dampness, pets and heat

did not. Of those subjects participating in the study, lung function was available for 532 subjects. There were 8 subjects who refused lung function testing and 13 who had unacceptable lung function (FEV_1 and FVC were identical).

Table 4-8 shows the comparison of demographic and health related variables for subjects with and without lung function measurements. Children without lung function measurements, or unacceptable tests were more likely to be females ($p = 0.02$) and were significantly younger ($p = 0.01$) than children with lung function measurements. The two groups are fairly evenly distributed with regards to atopic status, hospitalizations in the last 12 months, usually having a cough, respiratory illness in the past 12 months, low birth weight, breastfed, parental history of allergy, type of home, and home location (farm/non-farm). Important considerations with regards to lung function from the literature include age, sex, height and passive smoking and these variables were adjusted for in the analysis.[63,81] When associations between lung function variables and asthma or respiratory symptoms were examined, there were significant associations between asthma and lower FEF_{25-75} ($\beta = -0.154$; $p < 0.03$) and lower FEV_1/FVC ratio ($\beta = -0.019$; $p < 0.01$). An increase in FVC ($\beta = 0.062$; $p < 0.04$) was associated with a report of respiratory symptoms that included cough, phlegm or wheeze.

Based on the findings of the correlations between the seven farming activities, the relationships between pulmonary function variables (FEV_1 , FVC, $FEF_{25-75,}$ FEV_1/FVC ratio) and farming activities were examined in separate linear regressions for each farming activity while adjusting for age, sex, height, and parental smoking.[80] Table 4-9 shows the coefficients, the standard error (S. E.), and the significance level for each

Table 4-8 Comparison of demographic and health related variables for children with and without acceptable or no lung function measurements

	Lung function (n=532)	No lung function (n= 21)	p-value
Mean Age (years)	9.8 (± 2.30)	8.8 (±2.36)	0.01
	n (%)	n (%)	
Sex			
Male	263 (49.4)	5 (23.8)	0.02
Female	269 (50.6)	16 (76.2)	
Atopy*			
No	380 (76.6)	14 (77.8)	0.91
Yes	116 (23.4)	4 (22.2)	
Parental History of allergy			
No	275 (51.7)	11 (52.4)	0.95
Yes	257 (48.3)	10 (47.6)	
Breastfed			
No	112 (21.1)	6 (28.6)	0.27
Yes	420 (78.9)	15 (71.4)	
Passive Smoking			
No	444 (91.5)	17 (81.0)	0.76
Yes	88 (8.5)	4 (19.0)	
Farm Exposure 1st 12 Months of Life			
No	216 (40.6)	7 (33.3)	0.51
Yes	316 (59.4)	14 (66.7)	
Damp Housing			
No	411 (77.3)	18 (85.7)	0.36
Yes	121 (22.7)	3 (14.3)	
Type of Home			
Single family	487 (91.5)	18 (85.7)	0.35
Other	45 (8.5)	3 (14.3)	
Heat			
Gas	414 (77.8)	18 (85.7)	0.39
Other	118 (22.2)	3 (14.3)	
Current Pet			
No	300 (56.4)	13 (61.9)	0.10
Yes	232 (43.6)	8 (38.1)	

*Atopy n=514

Table 4-9 Linear regression models assessing associations between adjusted* lung function values and farming activities in study subjects (n=532)

Farming Variables	β	S.E.	p-value
Dependent Variable FEV_1			
Model 1 Haying	-0.001	0.051	0.96
Model 2 Harvesting	0.002	0.035	0.96
Model 3 Hay bales	0.034	0.035	0.33
Model 4 Feeding livestock	0.045	0.041	0.27
Model 5 Barns	0.017	0.041	0.68
Model 6 Cleaning Pens	-0.098	0.071	0.17
Model 7 Grain Bins	0.009	0.054	0.86
Dependent Variable FVC			
Model 1 Haying	0.057	0.053	0.28
Model 2 Harvesting	0.001	0.036	0.99
Model 3 Hay bales	0.030	0.037	0.42
Model 4 Feeding livestock	0.024	0.043	0.57
Model 5 Barns	-0.004	0.043	0.93
Model 6 Cleaning Pens	-0.118	0.075	0.12
Model 7 Grain Bins	-0.016	0.057	0.77
Dependent Variable FEF_{25-75}			
Model 1 Haying	-0.140	0.103	0.17
Model 2 Harvesting	-0.047	0.070	0.51
Model 3 Hay bales	0.025	0.071	0.72
Model 3 Feeding livestock	0.012	0.009	0.16
Model 4 Barns	0.083	0.083	0.32
Model 5 Cleaning Pens	-0.111	0.144	0.44
Model 6 Grain Bins	0.062	0.082	0.45
Dependent Variable FEV_1/FVC ratio			
Model 1 Haying	-0.013	0.011	0.22
Model 2 Harvesting	0.003	0.007	0.69
Model 3 Hay bales	0.005	0.008	0.48
Model 4 Feeding livestock	0.012	0.009	0.16
Model 5 Barns	0.008	0.009	0.35
Model 6 Cleaning Pens	0.002	0.015	0.91
Grain Bins	0.008	0.012	0.49

*each model adjusted for age, sex, height and passive smoking farming activity variable. None of the pulmonary function variables were associated with participation in any of the farming activity variables.

4.6 Summary

In this study population of 553 children in Grades 1 to 8 in Humboldt, Saskatchewan:

- Asthma prevalence was 18.8% and respiratory symptoms prevalence was 39.8%.
- The prevalence of asthma and the prevalence of respiratory symptoms did not differ between children living on farms and those living off farms.
- Children with asthma were more likely to be male, to have a parental history of allergy, and were more likely to be bottlefed as an infant.
- Similar to children with asthma, children with respiratory symptoms were also more likely to be male and have a parental history of allergy, but they were also more likely to be exposed to passive smoking in the home and to live in damp housing, and less likely to live in single family dwellings.

With regards to the associations between farming activities and asthma or respiratory symptoms:

- Children exposed to emptying and filling of grain bins were more likely to have asthma.
- Children who were exposed to haying, playing on or near hay bales, or cleaning pens were more likely to experience respiratory symptoms.

With regards to lung function, the results indicated that lung function variables were not associated with participation in any of the seven farming variables tested.

Chapter 5: Discussion

Findings from previous studies examining the relationship between respiratory health and farm living have been mixed. This thesis aimed to examine the association asthma, respiratory symptoms and selected farming activities in a rural population of Saskatchewan school children Grades 1 to 8. Asthma and respiratory symptoms were compared within 7 farming activities including; haying, harvesting, moving/playing with hay bales, feeding livestock, cleaning/playing in barns, cleaning pens and emptying/filling grain bins. The relationship between lung function and farming activities was also assessed.

5.1 Research Question #1

The response rate to this study was very good. Most children attending Grades 1 to 8 in Humboldt were included in the study with a response rate of approximately 87%. Acceptable pulmonary function test were obtained from 96% of the population returning questionnaires. The cross-sectional design had a primary purpose of examining the relationship between endotoxin and genetic factors in a general population. As this is a cross-sectional study, farming exposure, asthma and respiratory symptoms are assessed at a single point in time so it is not possible to determine whether the exposure preceded or resulted from the disease.[82] The cross-sectional design was appropriate to examine the association of home location and the seven farming activities with asthma and respiratory symptoms in this population of school age children. The overall prevalence of asthma shown in this study of children in Grades 1-8 was 18.8% which is a higher prevalence than was found in the 1993 Humboldt study (11.0% in children ages 6 to 13).[43] The increase in prevalence reflects similar increases worldwide. Asthma prevalence worldwide it is now between 16 and 20%.[5] Prevalence of ever asthma symptoms (wheezing or whistling in the chest in the past 12 months) in Phase Three of the International Study of Asthma and Allergies in Children (ISAAC) study conducted in 2002 to 2003 of 193,404 children ages 6 to 7 from 66 centers in 37 countries including Canada, and 304,679 children ages 13 to 14 from 106 centers in 56 countries, found a range of asthma prevalence in 6 to 7 year olds from 6.8% in Southeast Asia to 37.6% in Oceania.[83] Increases occurred more often than decreases for all levels of mean prevalence since Phase One of the study which was completed seven years earlier. In the 13 to 14 years age group, the prevalence of asthma symptoms ranged from 6.4% in Southeast Asia to 26.7% in Oceania. Schools in Saskatoon, Canada participated in Phases One and Three of the worldwide asthma study. Asthma prevalence in Phase One was 14.1% and it increased to 18.2% by Phase 3 for a percent change per year of 0.47 % for children 6 to 7 years of age. The prevalence found in this study was within the range of what has been found internationally.

The Student Lung Health Survey in 1995 to 1996 of 5 to 19 year olds from 136 public, private, and separate schools in nine health units across Canada including Saskatoon, found the national rate of asthma in Canada to be 16.3% while the ever asthma rate in Saskatoon was found to be 12.3%.[32] Habbick et al. using the ISAAC protocol for 6 to 7 and 13 to 14 year olds in Hamilton, Ontario and Saskatoon, Saskatchewan, found asthma prevalence (diagnosis of ever asthma) for 6 to 7 year olds to be 17.2 % in Hamilton and 11.2% in Saskatoon.[84] For 13 to 14 year olds the asthma prevalence was 19.2% in Hamilton and 12.2% in Saskatoon. The prevalence rate found in this study is higher than that found in Saskatoon in 1993 but similar to that reported as asthma symptoms in the 2003 ISAAC study at Saskatoon.[83]

This analysis of Humboldt children Grades 1 to 8 showed no significant difference in the prevalence of asthma for children who lived on farms/acreages compared to children who lived in town. There was also no significant difference in prevalence of respiratory symptoms for children who lived in town compared to children who lived on farms or acreages. Research of rural and non-rural differences for asthma and respiratory symptoms is limited in Canada; however, most of the literature indicates a lower prevalence of asthma and respiratory symptoms in children exposed to the farm particularly if that exposure is early in life [23,24,27] while some literature indicate an increased prevalence of asthma for children living on farms [25,50,51]

A study by Rennie found no difference between farm and acreage living location and non-rural locations in the prevalence of asthma or wheeze for 2,374 children who participated in a cross-sectional study of respiratory disease in rural central Saskatchewan.[8] Braun-Fahrlander et al. in a study of 812 rural children in Germany, Switzerland and Austria found that early farm life and early exposure to endotoxin showed reduced childhood asthma risk (OR =3.1, 95% CI: 1.2-5.0) for farm, (OR=5.9, 95% CI: 3.8-8.0) for non-farm. Similar results were seen for wheeze.[37] In a study of 2,283 8 to 10 year old Austrian children, living on a farm had lower prevalence of asthma compared with children who did not live on a farm ($p < 0.05$).[23] A study in Quebec of 1,199 rural students age 12 to 19 found asthma and wheeze were less common in adolescents raised on a farm (OR=0.70, 95% CI: 0.52-0.95) for current wheeze and (OR=0.59, 95% CI: 0.37-0.95) for asthma.[21] Salam et al. studied 4,244 children ages 8 to 18 from California and found that children in the study who were exposed to farm animals, farm crops, and dust had a higher risk of asthma than children in the study without those exposures (OR=1.88, 95% CI: 1.07-3.28).[50] Merchant et al., also based out of the US, conducted a study of 644 children birth to age 17 in Iowa and they found that asthma prevalence was higher in children living on farms that raised swine ($p < 0.05$).[51]

These inconsistencies of the research findings could be due to a variety of reasons, including difference in the study definitions of asthma. Many studies used a doctor diagnosed of asthma [27,51-54] while others have used a combination of respiratory symptoms or airways responsiveness to methacholine challenges to define asthma.[21] Some studies use a parental report of current wheeze as a definition of asthma,[25] others define asthma as a current use of asthma medication, while others define asthma only by a positive methacholine challenge result. The definition of asthma for this cross-sectional study was parental report of doctor diagnosed asthma. Doctor diagnosis of asthma has been used in previous studies of asthma, [29,32,43,63] and it has shown good agreement with physical examination by a physician (Kappa=0.79),[76] and have shown good reliability on repeat reporting by parents.[29,85,86]

Regional variation in the types of farming and farming practices is well known and could be one of the reasons for the differences in asthma prevalence in studies of farm children.[87]

The airways can be affected by these various components, as well there seems to be a dosage–time relationship which adds to the difficulty in ascertaining which exposure may be causing respiratory symptoms. In swine confinement, the move towards increased mechanization may not reduce, but may actually increase, respiratory exposures.[88]

Farming exposures have been shown to cause a variety of respiratory symptoms and conditions. Another factor that makes ascertaining which specific activities may be related with respiratory symptoms is the ‘healthy worker effect’.[88] Agricultural workers who are not healthy enough to handle the exposures, or are made sick by the exposures, then avoid those exposures. So what may look like a negative association between an exposure and respiratory symptoms may actually be reflecting a propensity for the workers, or children in this case children, to avoid certain exposures if they have respiratory symptoms or conditions.

5.2 Research Question # 2

Based on the findings of this study, certain farm related activities appear to be associated with an increased risk of asthma and respiratory symptoms. The farming activity with the least participation overall was cleaning pens (3.8%), while the greatest number of subjects participated in moving or playing with hay bales (19.5%) and in harvesting (19.7%). Children who were involved in haying had a two fold increase in asthma (OR = 2.35, 95% CI: 1.12-4.91). Respiratory symptoms were also significantly more likely to be found in children exposed to haying (OR=2.02, 95% CI: 1.06-3.88), moving or playing with hay bales (OR=1.83, 95% CI: 1.17-2.87) and cleaning pens (OR=2.65, 95% CI: 1.04-6.75).

Many features of the agricultural workplace make it an environment to potentially cause airway irritation and damage. Grain dust exposure is a cause of respiratory tract disease.[88] The chief component of grain dust, for example, is grain but a variety of other components can be found in grain dust as well including: nongrain plant matter; molds and spores (mainly *Aspergillus* and *Cladosporium* species); in humid grain, thermophilic *Actinomycete*; mycotoxins; bacteria and their biochemical components and excretions, such as endotoxins, peptidoglycans, and proteolytic enzymes; mites; insects such as the grain weevil; and other animal matter, including parts of insects, rodents, and birds and their excreta. Inorganic matter such as soil and silica, including quartz, is also frequently present.[89] Other organic dusts found in agricultural environments also contain a variety of components. In swine confinement buildings the dust is mainly composed of the animal feeds, but the main sources of microorganisms, allergens, and toxins are animal dander, urine, and feces.[89]

Haying was shown to be associated with both asthma and respiratory symptoms. There are many different types of hay, in Saskatchewan, the primary types of hay are alfalfa, timothy and bromegrass, and the hay and hay dust and as was the case for grain dust, hay dust can contain a wide variety of components, including mold and bacteria.[90] The composition of hay may vary depending on the above mentioned factors and may influence the reactivity of subjects to this variable. It would be useful to identify specific exposures children on farms are having with hay as in this study it was a primary risk factor for respiratory symptoms in children.

Cleaning pens may also expose children to higher dust concentrations and endotoxins and as has been shown in studies of adult poultry workers.[20,90] Research has shown there are important factors in a farming environment which make it a susceptible environment for asthma and respiratory symptoms. Exposures inside animal houses include gases and organic dusts containing fungi, bacteria and their constituents such as endotoxin.[91] A survey by Radon et al. in 2002 to 2004 of 6,937 adults ages 18 to 45 in Germany found the prevalence of self reported asthma symptoms increased with self-reported odor annoyance.[91] Endotoxin is a stable glycolipid component of the outer membrane of gram negative bacteria that can be collected and assayed in settled dust from mattresses or floors and is present in high amounts in swine confinement and poultry houses and is present in household dust, organic dust and air pollution.[92,93] Endotoxin has inflammatory effects and if inhaled, can exacerbate airflow obstruction and airway inflammation in individuals with allergic asthma.[93]

There is limited study of the associations between farming exposures and asthma and respiratory symptoms in children particularly for specific farming activities. A study by Rennie identified participation in farming activities on a regular basis in children who lived on farms was associated with increased risk of wheeze and a decrease in asthma.[29] Ernst et al. conducted a study of 1,199 adolescents 12 to 19 years of age and found current wheeze, AHR, and skin test positivity to inhaled allergens, to be significantly less common in adolescents raised on farm.[21] The differences Ernst et al. found were particularly pronounced in girls. Zekfeld et al. studied 800 schoolchildren ages 7 to 18 in rural Crete found children with regular animal contact, at any stage of life, were equally likely to be atopic, or to have current wheeze, than children with less frequent or no contact ($p < 0.001$).[94] Ege et al. in a 2007 study of 8,268 school age children ages 5 to 13 in 5 European countries found an inverse relationship between asthma and pig keeping (OR=0.77, 95% CI: 0.38-0.86), also between asthma and frequent stay in animal sheds (OR=0.71, 95%CI: 0.54-0.95), and with a child's involvement in haying (OR=0.56, 95% CI: 0.38-0.81).[60] A cohort study by Merchant et al. in 2005 of children birth through 17 years of age in Iowa, found that asthma was associated with children who live on a farm that raised swine (OR=1.88, 95% CI: 1.02-3.45) and the level of risk increased when children live on a farm that raised swine and added antibiotic to animal feed (OR=2.47, 95% CI: 1.29-4.74).[51]

Associations between asthma, wheeze, and farming in adults have been identified. Senthilselvan et al. identified grain farming as a significant predictor for asthma and wheeze (OR=1.9; 95% CI: 1.21-3.2), $p < 0.05$ for asthma, (OR=1.7, 95% CI: 1.3-2.4) $p < 0.001$ for wheeze.[17] Kirychuk et al. in a study of grain and poultry workers in Saskatchewan, Alberta and Manitoba and found the poultry workers to have a greater prevalence of current and chronic respiratory conditions.[20] It is possible different farming activities are not as bothersome, or that perhaps children are not exposed as directly to certain farming activities as are adults.

5.3 Research Question #3

The results found in this analysis assessed the association between lung function and farming activity. The group of 21 subjects who did not complete lung function testing were more likely to be female and younger than the group of 532 who completed the lung function. Although refusal of lung function is not known to be associated with gender, it is quite likely that younger children may have been more reluctant to perform the pulmonary function testing. As well, children who consented to testing but have unacceptable lung function have been shown to be younger in age.[68,95]

There were no significant associations identified between lung function measurements (FEV_1, FVC, FEF_{25-75}, and FEV_1 /FVC) and any of the seven farming activities. No literature was uncovered that had explored relationships between lung function and farming activities or farming environments in children. However, literature examining lung function in adult farming populations has shown correlations between reduced lung function measures on exposure to farming environments, most notably those environments that involve animal production.[96,97] Important considerations for the findings of no association between lung function and farming operations in the current study of children could be that lung function was conducted on each subject at one time point and during the winter, a period of time when many of the farming operations are not occurring (e.g., haying, harvesting) and children are in school. Given that asthma is characterized by intermittent symptoms and that many farming activities occur only at certain times of the year, it may be of importance to conduct lung function on each subject at more than one study point in time and during peak periods of exposure to the farming activities under investigation.

In the current study asthma was associated with a decrease in both FEF_{25-75} and FEV_1/FVC ratio. Weiss et al. showed lowered FEF_{25-75} in 5 to 9 year olds with active asthma compared to children with no history of asthma.[68] Lawson identified an association between lower lung function (FEV_1, FEF_{25-75}, and FEV_1/FVC) and asthma in study of 579 Saskatchewan school age children.[63] However, Droste et al. found no association between asthma and lower lung function in 7 to 8 year old children [69] It may also not be possible to clearly identify children with asthma by lung function alone. It has been shown that children with mild asthma may not have airflow limitation as measured by airway hyper-responsiveness (AHR) challenges. Salome et al. assessed AHR using histamine inhalation in 2,363 Australian schoolchildren aged 8 to11 years. Although AHR was closely associated with asthma ($p < 0.001$), however, of those with a diagnosis of asthma only a small proportion (12.8%) had AHR.[76]

It has been shown that children whose asthma is under good control may experience normal lung function and little or no change in FEV_1 post bronchodilator.[98] As well it is important to recognize that asthma is characterized by intermittent exacerbations symptoms and if pulmonary function is conducted during periods when asthma is clinically stable, the FEV_1 values are likely to be within normal range.[99] However, AHR may still be present. Bisgaard et al. found that in a cross-sectional study of 2,390 children from 550 families at high risk for asthma, there were 919 children with a clinical history of asthma that was currently under treatment with prophylactic asthma therapy for at least 1 year. In this group AHR was found in 83% of children while the mean FEV_1 was at 89% of predicted, above the cut off of 80%, commonly used to identify abnormal lung function. AHR measures have been used in epidemiological studies.[21,86] However, they are more difficult to complete in the field and may result in a selection bias of children out of the study who may not want to participate in more invasive measurements such as methacholine challenge and exercise testing.

5.4 Potential Limitations and Sources of Bias

The analysis for this study was done on data collected for a different purpose and is, therefore, bound to the data available. The data was taken from the results of a cross-sectional study with the primary purpose of examining the relationship between endotoxin and genetic factors in a general population. Cross-sectional studies are a type of descriptive epidemiologic study in which exposure and disease statuses are assessed simultaneously.[100] As this was a cross-sectional study farming exposure, asthma, and respiratory symptoms are assessed at a single point in time so it is not possible to determine whether the exposure preceded, or resulted from, the disease. In this thesis some associations were noted between certain exposures and asthma and respiratory symptoms. It is difficult to ascertain the roles these exposures played however, the directions of association found in this study were similar to those found in other studies of respiratory symptoms and disease in children. The response rate to this study was excellent as was the participation of children in the lung function testing.

Parents of children in this study answered questionnaires. Parental reporting can be a source of bias. Parents needed to know which farming activities their children were involved in which makes the results prone to reporting bias. It would be best to use a more direct form of measurement of the exposures using calibrated equipment but those measurements were not available for this analysis. It is possible that parents also could have perceived that reporting their child to be in or near these activities could mean they are not protecting the welfare of their children, so again, a possible reporting bias exists. To eliminate the possibility that parents would under-report their child's involvement in farming activities, questions on farming activities were worded to include bystander activity. The questionnaire asks for an hour or more of exposure in or near the farming activities in the past 12 months. Any exposure of that duration was considered active participation in farming activity. Recall of activities over 12 months may have been difficult. Interviewing parents in order to get a more accurate idea of the length and types of farming exposures, or enhanced questions, or perhaps a trained interviewer presenting the questions, would allow for better data accumulation. This type of data would perhaps enhance our understanding of which particular activities are avoided by children with respiratory symptoms, which seem to be associated with less respiratory symptoms, and which are not associated with respiratory symptoms. Using questionnaires may also result in misclassification from recall bias and response bias due to awareness of the hypothesis or parents' feelings of guilt for, for example, smoking in the presence of their children. Recall bias can result in an underestimate of exposures but it tends to result in an overestimate.[101] Systematic error was minimized by using standardized questions on the questionnaire and standardized techniques to obtain lung function.[5,10,67,73]

In most epidemiological surveys the estimated prevalence of asthma is based on questionnaire responses, which may depend on the individual's perception as well as medical consulting habits in a given population. The design of this study also could not identify trends in asthma diagnosis over time. Asthma has been defined in many different ways; many studies use a physician diagnosis of asthma.[8,11,25,27,37] Generally, "the diagnosis of asthma depends on expert physician correlation of patient history, physical examination and pulmonary function test results."[102]

This was a cross-sectional study which is useful to assess the prevalence of a disease and certain risk factors in a population and to generate hypotheses for further study.

5.5 Future Research

There are several potential areas for future research in this area. A cohort study of a population of individuals without asthma, a birth cohort for example, to see how asthma develops in farming and non-farming populations over a period of years. A potential focus of future research may include targeting study on the farming activities shown to be associated with asthma and respiratory symptoms, or examining the association between asthma and home location or certain farming exposures using case control, prospective, or retrospective study design. Another area for research would be validate the diagnosis of asthma perhaps by including methacholine challenge and/or review of physician records of diagnosis to ensure similar diagnostic criteria are being used. Perhaps a combination of questionnaire and in person interview of parents and children could provide a more comprehensive picture of the farming environment. Using objective measures such as air sampling in the home and in the farming activity area, ideally with the child wearing a sampling device while exposed, could help to quantify the exposures found in the farming environment that could be related to asthma.

5.6 Conclusions

The prevalence of asthma in children found in this study is congruent with current worldwide reports of prevalence. Asthma prevalence found in this study was 18.8% and respiratory symptoms prevalence was 39.8%. Children with asthma were more likely to be male, to have a parental history of allergy, and were more likely to be bottlefed as an infant. Although the concordance between asthma and respiratory symptoms was small, children with respiratory symptoms were very similar to children with asthma in that they were also more likely to be male and have a parental history of allergy, but unlike children with an asthma diagnosis they were more likely to be exposed to passive smoking in the home and to live in damp housing, and less likely to live in single family dwellings. Based on the findings for respiratory symptoms it would be important to include this outcome in studies as it may be an indicator of some children who might have undiagnosed asthma. Although this study did not find a difference in prevalence between children living on farms/acreages or those living in towns, the findings support the results of studies conducted with most North American populations of similar ages.

With regards to the associations between farming activities and asthma or respiratory symptoms; children exposed to emptying and filling of grain bins were more likely to have asthma and children who were exposed to haying, playing on or near hay bales, or cleaning pens were more likely to experience respiratory symptoms. These associations with certain farming activities and asthma or respiratory symptoms support the findings for adult participants in farming environments. The well known association between farming exposures and increased respiratory symptoms or disease in adult farmers compared with non-farming populations, suggests the urgent need to examine whether these exposures are critical during childhood and influence the development of respiratory disease in adult farming populations. The farming environment is an occupational environment and the respiratory exposures experienced in children are similar exposures experienced in adults and from a public health perspective farming environments found in this study to be associated with asthma and respiratory symptoms should be targeted as “no kid” zones.

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Appendices

Appendix A

Consent Form and
Letter to Parents

Humboldt Lung Study (Children 6 – 15yrs)
Consent for Health Measurements
Confidential When Completed

PERMISSION to PARTICIPATE:

This study will look at the respiratory health of children and those things around them that can affect it. The study is being done by Dr. Dosman and Associates at the University of Saskatchewan. I understand that as part of this study the researchers will need to conduct assessments on my child (*First and Last Name)*________________________. I give permission for my child to participate in this health survey. I understand that this will involve measurements of my child's height, waist, weight, and blood pressure. It will involve a simple test of breathing that will measure how much air my child can blow out in a single breath. It will also involve swabbing of the inside cheeks of the mouth for the study of how respiratory diseases are inherited. This will involve carefully taking swabs from the inside cheeks of the mouth. This is not uncomfortable.

If agreed to, the health assessment will also include skin testing for allergies. The skin testing will take place in the school by a qualified registered nurse. In the skin testing procedure, 6 small drops of liquids containing allergen material will be placed on my child's arm. The surface of the skin underneath each drop will be scratched lightly. This procedure may cause some local itching at the scratched sites for some children. The itchiness will disappear within 1 hour following the test. We will keep all children at the test site until the itchiness is gone. A copy of the skin testing findings will be provided upon request once all study information is collected.

All information from this health assessment will be used for research purposes only and will be grouped with the information from other children. I understand that my child can refuse to participate at any time in any part of the study measurements and will have a chance to ask questions before the measurements are done. The researchers respect the decision by the child to participate or not. I have explained this permission slip to my child.

Please identify the assessments your child can participate in (Circle **ALL** that apply):

Blood Pressure	**Yes**	**No**
Lung Function (includes height, weight and hip measurements)	**Yes**	**No**
Cheek Swabs	**Yes**	**No**
Skin Testing	**Yes**	**No**

I have explained this consent to my child and he or she can participate in testing as circled.

____
Signature of Parent or Guardian

____
Signature of Child

____
Signature of Research Assistant

Date ________________________

Parent's Name (*Please Print Below*) Address

____

If you have any concerns about the health assessment, please contact:
Dr. J. Dosman, College of Medicine, University of Saskatchewan Phone: 1-306-966-8286. If you have any questions about your rights as a research subject or concerns about your experiences while participating in this study you should contact the Chair of the Biomedical Research Ethics Board, C/o the Office of Research Services, University of Saskatchewan at (306) 966-4053.

January 2003

Study of Indoor Air and Children's Respiratory Health

Dear Parent or Guardian,

In January 2000, we conducted a study of children's respiratory health in Estevan with children in Grades 1 to 6. As a result of the findings from that study, we are proposing to continue our research by studying in more detail, the indoor environment of children living in Estevan. As newcomers to the Estevan schools since our last study or as participants in our last study, we would like some current information concerning your child's respiratory health and for possible participation in a follow-up study. Enclosed is a questionnaire that asks about your child's breathing and other factors. This study is being done to learn more about the current respiratory health of school age children and has the co-operation of your local school board and is sponsored by the Saskatchewan Lung Association.

All students attending Grades 1 to 6 will receive a questionnaire. A separate questionnaire should be completed for each child. The questionnaire takes about 15 minutes to answer and should be filled out by the parent who knows more about the child's health. Please read and follow the instructions on the inside page. When you have completed the questionnaire, seal it in the envelope supplied and return it to the child's school. We will collect all of the questionnaires from the schools.

The second page of the questionnaire requests your permission to telephone you about the follow up study which will be explained at the time of telephone contact. Briefly, we will be looking at indoor home air quality that will require a visit to your home and a health assessment of your child by a registered nurse. If you have any concerns or questions, please call us at 1-306-966-7886 or you can leave a message at your child's school. We will return your call.

All personal information will be kept strictly confidential and used only for this research. The part of the questionnaire with your child's name or other information that could identify your child will be kept separate from your other answers and will be held in a secure place by the principal investigator. No information that could identify your child or family will be used when we report the results. Your answers will be combined with the answers from other parents.

Your participation in this study is free and voluntary and will be very helpful in understanding the respiratory health of other children living in Saskatchewan. If for some reason you decide not to be part of this study, it will not compromise you or your child's relationship with your school or health care. If you cannot participate, we ask that you kindly return the questionnaire to the school. Please keep this letter for future reference.

Thank you for your cooperation.

Sincerely,

Donna Rennie

Dr. Donna C. Rennie
Principal Investigator and Associate Professor
College of Nursing and Institute for Agriculture Rural and Environmental Health
University of Saskatchewan
Ph: 1-306-966-7886 or 1-306-966-6234 Email: rennied@sask.usask.ca

Institute of Agricultural Rural and Environmental Health (I.ARE.H)
Centre for Agricultural Medicine, University of Saskatchewan
103 Hospital Drive, Saskatoon SK S7N 0W8 Telephone: (306) 966-8286 Facsimile: (306) 966-8799

Appendix B

Ethics Approval

UNIVERSITY OF SASKATCHEWAN

Ethics Office

Room 302 Kirk Hall
117 Science Place
Saskatoon SK S7N 5C8 Canada
Telephone: (306) 966-2975
Facsimile: (306) 966-2069

June 16, 2006

BIO #06-120

Principal Investigator:
Dr. Donna Rennie
College of Nursing, Institute of Agricultural Rural and Environmental Health – I.ARE.H
Room 3601
Royal University Hospital
103 University Drive
Saskatoon, SK S7N 0W8

Student Investigator:
Pamela Farthing (MSc. Candidate)
Department of Community Health and Epidemiology

Project Title:
Farming Activities and Respiratory Health in School Age Children

Thank you for submitting the above-referenced protocol for REB review.

In your application you stated that this research will involve the secondary use of an electronic copy of de-identified data, that original survey responses will not be available, and that no participant recruitment will be done. You have further assured me that no contact will be made with any subjects, that the de-identified data will be used for research purposes only, and that, if/when published, the results will be presented in aggregate fashion.

Accordingly, as outlined in the Tri-Council Policy Statement, this project is not subject to further ethics review

It should be noted that although your project is exempt of ethics review; your project should be conducted in an ethical manner and in accordance with the information that you submitted.

It should be further noted that any deviation from the original methodology and/or research question should be brought to the attention of the Biomedical Research Ethics Board for further review.

Notwithstanding, research investigators must ensure that the project is carried out in keeping with the Saskatchewan Health Information Protection Act (HIPA).

Sincerely,

Michel Desautels, Ph.D., Chair
University of Saskatchewan
Biomedical Research Ethics Board

Appendix C

Questionnaire for Fourth Humboldt Survey 2003-2004
Elementary School Version

Confidential when complete

Questionnaire for the Fourth Humboldt Survey 2003-2004
Elementary School

This questionnaire can be answered by checking the best answer or by filling in a blank with a number or word(s).

Example 1:

Does this child usually have a cough?
No ___ Yes _✔_

Example 2:

How long has this child lived in the current residence? Years _6_

❖ - ❖ - ❖ - ❖ - ❖

FOR OFFICE USE:

Personal I.D.: ______________

Family I.D.: ______________

Child's name:

____
Last First

Tel. No.: ______________

Street address: ______________

Father's name:

____
Last First

Mother's name:

____
Last First

Grade ______ Teacher ______________

If the child has any brothers and sisters who are aged 6 to 17 years and presently living in Humboldt, list their names:

	Last	First	Age
1.			
2.			
3.			
4.			
5.			

Did the parents participate the 2003 survey?

Father No ___ Yes ___
Mother No ___ Yes ___

COUGH

A. Does this child usually have a cough?

No __ Yes __ Don't know __

B. Does this child usually cough at all on getting up, or first thing in the morning?

No __ Yes __ Don't know __

C. Does this child usually cough at all during the rest of the day?

No __ Yes __ Don't know __

Or at night? No __ Yes __ Don't know __

If YES to A, B, or C, answer D:

D. Does this child usually cough like this on most days as much as 3 months in a row out of the year?

No __

Yes __ past 12 months only

Yes __ past 12 months and other years

PHLEGM

A. Does this child usually have congestion in the chest or bring up phlegm with cold?

No __ Yes __ Don't know __

B. Does this child usually have congestion in the chest or bring up phlegm other than with cold?

No __ Yes __ Don't know _

If **YES**, has this congestion or phlegm been present for as much as 3 months in a row out of the year?

No __

Yes __, past 12 months only

Yes __, past 12 months and other years

WHEEZING

A. Does this child chest ever sound wheezy or whistling:

1.When the child has a cold?

No __ Yes __ Don't know

2. Occasionally apart from colds?

No __ Yes __ Don't know __

3. Most days?

No __ Yes __ Don't know __

4. Or nights?

No __ Yes __ Don't know __

If **YES** to 1, 2 or 3, for how many years has wheezing been present?

Number of years____

B. Has this child ever had an attack of wheezing that has made him/her feel short of breath?

No __ Yes __ Don't know __

If **YES**, has he/she ever required medicine or treatment for the(se) attack(s)?

No __ Yes __

C. Does this child ever get attacks of wheezing after he/she has been playing hard or exercising?

No __ Yes __ Don't know __

CHEST ILLNESSES

A. **During the past 12 months**, has a doctor ever said this child had any of the following chest illness:

1. Asthma No __ Yes __
2. Bronchitis No __ Yes __
3. Pneumonia No __ Yes __
4. Hay fever No __ Yes __
5. Sinus trouble No __ Yes __
6. Pulmonary tuberculosis No __ Yes __
7. Whooping cough No __ Yes __
8. Croup No __ Yes __
9. Other chest illness (including chest operations and injuries) No __ Yes __

Please Specify: ____________________

If no to asthma, Skip to D

B. If **YES** to asthma, **during past 12 months** how many times has the child required services for asthma from the following places

Emergency room ____

Doctor's office ____

2

C. Which of the following statement best describes this child's asthma medication use **in the past 12 months?**

Never in the past 12 months_____
At least once in the past 12 months_____
At least once per month_____
At least once per week_____
Every day_____

D. **Before the past 12 months**, has a doctor ever said this child had any of the following chest illness:

1. Asthma No __ Yes __
2. Bronchitis No __ Yes __
3. Pneumonia No __ Yes __
4. Hay fever No __ Yes __
5. Sinus trouble No __ Yes __
6. Pulmonary tuberculosis No __ Yes __
7. Whooping cough No __ Yes __
8. Croup No __ Yes __
9. Other chest illness (including chest operations and injuries) No __ Yes __
Please Specify: ____________________

E. If **YES** to asthma in either question A or D, at what age was the asthma first diagnosed?

Age___

PAST ILLNESSES - GENERAL

A. **<u>During</u> the past 12 months**, was this child seen by a doctor for:

1. Stomach acidity of reflux? No __ Yes __
2. An ear infection? No __ Yes __
3. An injury? No __ Yes___

B. **During the past 12 months**, has this child missed more than 1 week of school because of a chest illness? No __ Yes___

C. **During the past 12 months**, was this child kept over night in the hospital for any illness?

No __ Yes __

If **YES**, how many times? Times____
Please list hospitalizations

Diagnosis	Length of stay (days)
1. ____________	______________
2. ____________	______________

E. **<u>Before</u> the past 12 months**, was this child ever kept over night in the hospital for any illness?

No __ Yes __ Don't know __

If **YES**, how many times? Times __
Please list hospitalizations

Diagnosis	Length of stay (days)
1. ____________	______________
2. ____________	______________
3. ____________	______________

F. Did this child have an operation to remove the tonsils or adenoids? No __ Yes __

G. Has a doctor ever said this child had:

1. Diabetes No __ Yes __
2. Heart disease or defect No __ Yes __
3. High blood pressure No __ Yes __
4. Cystic fibrosis No __ Yes __

FAMILY HISTORY

A. Has the biological father of this child had:

1. Chronic bronchitis, emphysema, or chronic obstructive lung disease
No __ Yes __ Don't know __
2. Asthma No __ Yes __ Don't know __
3. Diabetes No __ Yes __ Don't know __
4. Heart disease or defect
No __ Yes __ Don't know __
5. High blood pressure
No __ Yes __ Don't know __
6. Allergy No __ Yes __ Don't know __
7. Hay fever No __ Yes __ Don't know __
8. Eczema No __ Yes __ Don't know __

B. Has the biological mother of this child had:

1. Chronic bronchitis, emphysema, or chronic obstructive lung disease
No ___ Yes ___ Don't know ___
2. Asthma No ___ Yes ___ Don't know ___
3. Diabetes No ___ Yes ___ Don't know ___
4. Heart disease or defect
No ___ Yes ___ Don't know ___
5. High blood pressure
No ___ Yes ___ Don't know ___
6. Allergy No ___ Yes ___ Don't know ___
7. Hay fever No ___ Yes ___ Don't know ___
8. Eczema No ___ Yes ___ Don't know ___

C. What is the total number of brothers and sisters(excluding half-brothers and half-sisters) this child has? Number ___

D. Within this family what is the birth order of this child? (Circle) 1 2 3 4 5 6 7 8

E. How many older brothers and sisters of the child have had the following conditions?

1. Asthma Number ___
2. Diabetes Number ___
3. Heart disease or defect Number ___
4. High blood pressure Number ___

F. How many younger brothers and sisters of the child have had the following conditions?

1. Asthma Number ___
2. Diabetes Number ___
3. Heart disease or defect Number ___
4. High blood pressure Number ___

PASSIVE SMOKING

A. Does any family member smoke cigarettes regularly in your home at present?
No ___ Yes ___

If YES, how many persons smoke cigarettes?
Number ___

How many cigarettes do they smoke per day in total? Cigarette/day ___

B. Are this child's parents currently smoker(s)?

1. Father Yes ___
No, but ex-smoker ___
No, never smoker ___

2. Mother Yes ___
No, but ex-smoker ___
No, never smoker ___

C. Since this child's birth, how many years has the parents smoked?

1. Father ___ Years
2. Mother ___ Years

D How many cigarettes do they smoke per day at home? Cigarette/day ___

1. Father No ___ Yes ___
2. Mother No ___ Yes ___

E. Does any family member smoke a pipe or cigars regularly in your home at present?

No ___ Yes ___

If YES, how many persons smoke a pipe or cigar? Number ___

F. Did this child's mother smoke while pregnant with this child?

No ___ Yes ___ Don't know

DRINKING

A. How many cups of coffee does the child drink a day? Cups ___
a week? Cups ___

B. How many glasses of soft drink does this child drink a day? Glasses ___
a week? Glasses___

4

ALLERGIES

A. Has this child ever had an allergic reaction to any of the following?

House dust	No ___ Yes ___
Grain dust	No ___ Yes ___
Pollen	No ___ Yes ___
Trees	No ___ Yes ___
Grasses	No ___ Yes ___
Dog or Cat	No ___ Yes ___
Birds/feathers	No ___ Yes ___
Farm animals	No ___ Yes ___

Specify animal type____________________

B Has this child ever had an allergic reaction to things that:

1. Are eaten or ingested, (e.g. food or medicine)? No ___ Yes ___

2. Come in contact with the skin (e.g. wool, detergents or metals) No ___ Yes ___

C. During the past 12 months has this child ever taken care of cattle, hogs, poultry, horses or other livestock?

No ___ Yes ___

LIVING ENVIRONMENT

A. How long has this child lived in your current home? Years ___

B. Which best describes the building in which this child lives?

A mobile home or trailer ___
A one-family house not attached to any other house ___
A one family house attached to other house(s) ___
A building for 2 families ___
A building for 3 or more families ___

C. About which year was this building originally built?
Year________ Don't know______

D. Where is your home located?
Farm_____
Acreage_____
In town_____

E. How many rooms other than hallways or bathrooms are there in your home?
Rooms___

F. How many people live in your home?
Number ___

G. How is your home heated in winter?
Gas furnace ___
Electricity ___
Steam or hot water___
Other, specify: ____________________

H. Do you have any of the following in your home?

Central Air conditioner	No ___ Yes ___
Room air conditioner	No ___ Yes ___
Air filter	No ___ Yes ___
Humidifier	No ___ Yes ___
Dehumidifier	No ___ Yes ___
Fireplace	No ___ Yes ___

I. Does your house have any damage caused by dampness (e.g., wet spots on walls, floors)? No ___ Yes ___

J. Are there signs of mold or mildew in any living areas of your home? No ___ Yes _

K. Do you currently have any pets living inside your home?

Dog(s)	No ___ Yes ___
Cat(s)	No ___ Yes ___
Bird(s)	No ___ Yes ___

Other, specify: ____________________

5

L. During the child's lifetime, have you had a dog, cat or bird living in your home?

No ___ Yes ___

M. **In the past 12 months** has this child had a farm-related injury?

No ___ Yes ___

If **YES**, please describe how and what happened.

____
____
____

N. In the first 12 months of this child's life did this child:

Live on a farm No ___ Yes ___

Visit a farm more than 3 times No ___ Yes ___

Visit a farm 3 times or less No ___ Yes ___

If **YES** to living on or visiting a farm, what type of farm was it?

Grain_____

Mixed_____

Livestock_____

O. In the past 12 months has this child spent more than 1 hour on a regular basis near any of the following activities?

1. Haying No ___ Yes___
2. Harvesting No ___ Yes ___
3. Moving or playing with hay bales No ___ Yes ___
4. Feeding livestock No ___ Yes ___
5. Cleaning or playing in barns No ___ Yes ___
6. Cleaning pens No ___ Yes ___
7. Emptying or filling grain bins No ___ Yes ___
8. Pouring or mixing farm chemicals No ___ Yes ___
9. Moving or raking lawns No ___ Yes ___

SPORTS

A. Does your child participate in sports in school?

No ___ Yes ___

B Does your child play sports outside school?

No ___ Yes ___

C. Is your child now taking physical education or gym at school?

No ___ Yes ___

D. How good is your child's physical fitness?

Excellent ___
Good ___
Average ___
Below average ___
Poor ___

WEIGHT

A. Do you consider your child is:

Underweight? ___
Just about right weight? ___
Overweight? ___

B. Has your child ever tried to lose weight?

No ___ Yes ___

C. Is your child presently trying to lose weight, gain weight or neither?

Lose weight ___
Gain weight ___
Neither ___

D. If your child is presently trying to lose weight, which of the following ways of losing weight are being used?

Dieting No ___ Yes ___
Exercising No ___ Yes ___
Skipping meals No ___ Yes ___
Smoking No ___ Yes ___
Taking diet pills No ___ Yes ___
Attending programs No ___ Yes ___
Eating healthy No ___ Yes ___
Other, specify: ______________________

TELEVISION

A. Does your child watch television every day or almost every day?

No ___ Yes ___

B. How many hours does your child spend on watching television or playing video games per day on an average?

Weekday: _____ hours

Weekend: _____ hours

C. How many hours did your child spend on watching television or playing video games during last week in total?

_____ hours

PERSONAL INFORMATION

A. Child's sex: Male ___ Female ___

B. Child's date of birth: ____ ____ ____
Month Day Year

C. Child's age: ____

D. Country of birth: ___________________

E. What is this child's ethnic origin?

____

F. What did this child weigh when he/she was born?
Under 3 pounds ___
3 to 5 pounds ___
Over 5 pounds ___
Don't know ___

G. Was this child breastfed No ___ Yes ___

If **YES**, for how long?
Weeks_____ or Months___
(Please specify amount of time)

OTHER INFORMATION

A. Do you think your child's health is ..

Excellent _
Good _
Fair _
Poor _

B. What is your relationship to this child?

Biological father _
Biological mother _
Adoptive parent _
Stepparent _
Grandparent _
Legal guardian _
Other _

C. Does this child live in a:
One parent home ___
Two parent home ___

D. What is today's date:

_____ _____ _____
Month Day Year

THE END

Comments:

Appendix D

Regression Models

Appendix D

SPSS Output for Regression Analyses

Codes for variables

Variable Name	Description	Value	Referrent
age	age of subject	continuous	
sex		male=1 female=2	male
damp1	dampness/mold in the home	no=0 yes=1	no
psmoke	smoking in the home	no=0 yes=1	no
pallerghx	parental history of allergy	no=0 yes=1	no
cpet	dog, cat or bird in the home	no=0 yes=1	no
hay	haying	no=0 yes=1	no
harvest	harvesting	no=0 yes=1	no
movable	moving or playing with hay bales	no=0 yes=1	no
feed	feeding livestock	no=0 yes=1	no
clnbarn	cleaning or playing in barns	no=0 yes=1	no
clnpen	cleaning pens	no=0 yes=1	no
grainbin	emptying or filling grain bins	no=0 yes=1	no

Haying

Variables in the Equation

		B	S.E.	Wald	df	Sig.	Exp(B)	95.0% C.I.for EXP(B)	
								Lower	Upper
Step 1(a)	age	-.082	.040	4.207	1	.040	.921	.852	.996
	sex(1)	-.405	.185	4.819	1	.028	.667	.464	.957
	damp1(1)	.880	.217	16.471	1	.000	2.410	1.576	3.685
	psmoke(1)	.583	.247	5.569	1	.018	1.791	1.104	2.905
	pallerghx(1)	.727	.184	15.621	1	.000	2.068	1.442	2.965
	cpet(1)	-.128	.189	.456	1	.500	.880	.607	1.275
	hay(1)	.704	.332	4.502	1	.034	2.022	1.055	3.876
	Constant	-.077	.434	.031	1	.859	.926		

a Variable(s) entered on step 1: age, sex, damp1, psmoke, pallerghx, cpet, hay

Harvesting

Variables in the Equation

		B	S.E.	Wald	df	Sig.	Exp(B)	95.0% C.I.for EXP(B)	
								Lower	Upper
Step 1(a)	age	-.079	.040	3.912	1	.048	.924	.854	.999
	sex(1)	-.431	.184	5.503	1	.019	.650	.453	.931
	damp1(1)	.868	.216	16.101	1	.000	2.383	1.559	3.642
	psmoke(1)	.631	.248	6.474	1	.011	1.880	1.156	3.059
	pallerghx(1)	.700	.184	14.506	1	.000	2.013	1.404	2.886
	cpet(1)	-.120	.189	.407	1	.524	.887	.612	1.284
	harvest(1)	.345	.229	2.264	1	.132	1.412	.901	2.212
	Constant	-.100	.435	.052	1	.819	.905		

a Variable(s) entered on step 1: age, sex, damp1, psmoke, pallerghx, cpet, harvest

Hay Bales

Variables in the Equation

		B	S.E.	Wald	df	Sig.	Exp(B)	95.0% C.I.for EXP(B)	
								Lower	Upper
Step 1(a)	age	-.083	.040	4.243	1	.039	.921	.851	.996
	sex(1)	-.447	.185	5.853	1	.016	.640	.445	.919
	damp1(1)	.859	.217	15.633	1	.000	2.362	1.543	3.617
	psmoke(1)	.548	.249	4.867	1	.027	1.730	1.063	2.817
	pallerghx(1)	.691	.184	14.084	1	.000	1.997	1.391	2.865
	cpet(1)	-.127	.190	.450	1	.502	.880	.607	1.277
	movbale(1)	.603	.230	6.896	1	.009	1.828	1.165	2.868
	Constant	-.084	.435	.037	1	.847	.920		

a Variable(s) entered on step 1: age, sex, damp1, psmoke, pallerghx, cpet, movbale

Feeding Livestock

Variables in the Equation

		B	S.E.	Wald	df	Sig.	Exp(B)	95.0% C.I.for EXP(B)	
								Lower	Upper
Step 1(a)	age	-.081	.040	4.102	1	.043	.922	.852	.997
	sex(1)	-.440	.184	5.704	1	.017	.644	.449	.924
	damp1(1)	.877	.216	16.424	1	.000	2.404	1.573	3.675
	psmoke(1)	.570	.247	5.297	1	.021	1.767	1.088	2.871
	pallerghx(1)	.717	.184	15.233	1	.000	2.048	1.429	2.935
	cpet(1)	-.129	.189	.461	1	.497	.879	.607	1.274
	feed(1)	.522	.267	3.829	1	.050	1.686	.999	2.844
	Constant	-.074	.434	.029	1	.865	.929		

a Variable(s) entered on step 1: age, sex, damp1, psmoke, pallerghx, cpet, feed

Barns

Variables in the Equation

		B	S.E.	Wald	df	Sig.	Exp(B)	95.0% C.I.for EXP(B)	
								Lower	Upper
Step 1(a)	age	-.082	.040	4.156	1	.041	.922	.852	.997
	sex(1)	-.442	.184	5.767	1	.016	.643	.448	.922
	damp1(1)	.854	.216	15.596	1	.000	2.349	1.537	3.588
	psmoke(1)	.574	.247	5.400	1	.020	1.775	1.094	2.880
	pallerghx(1)	.737	.184	16.052	1	.000	2.089	1.457	2.995
	cpet(1)	-.112	.189	.353	1	.553	.894	.617	1.294
	clnbarn(1)	.469	.268	3.069	1	.080	1.599	.946	2.702
	Constant	-.072	.434	.028	1	.868	.930		

a Variable(s) entered on step 1: age, sex, damp1, psmoke, pallerghx, cpet, clnbarn.

Cleaning Pens

Variables in the Equation

		B	S.E.	Wald	df	Sig.	Exp(B)	95.0% C.I.for EXP(B)	
								Lower	Upper
Step 1(a)	age	-.082	.040	4.182	1	.041	.921	.852	.997
	sex(1)	-.404	.185	4.779	1	.029	.668	.465	.959
	damp1(1)	.849	.216	15.404	1	.000	2.337	1.529	3.570
	psmoke(1)	.584	.247	5.598	1	.018	1.794	1.105	2.910
	pallerghx(1)	.743	.184	16.253	1	.000	2.101	1.465	3.015
	cpet(1)	-.133	.190	.492	1	.483	.876	.604	1.269
	clnpen(1)	.974	.477	4.165	1	.041	2.648	1.039	6.748
	Constant	-.059	.434	.018	1	.892	.943		

a Variable(s) entered on step 1: age, sex, damp1, psmoke, pallerghx, cpet, clnpen.

Grain Bins

Variables in the Equation

		B	S.E.	Wald	df	Sig.	Exp(B)	95.0% C.I.for EXP(B)	
								Lower	Upper
Step 1(a)	age	-.081	.040	4.062	1	.044	.922	.853	.998
	sex(1)	-.418	.185	5.114	1	.024	.659	.459	.946
	damp1(1)	.849	.216	15.486	1	.000	2.337	1.531	3.568
	psmoke(1)	.602	.247	5.955	1	.015	1.825	1.126	2.959
	pallerghx(1)	.722	.183	15.526	1	.000	2.058	1.437	2.946
	cpet(1)	-.111	.188	.350	1	.554	.894	.618	1.294
	grainbin(1)	.305	.358	.724	1	.395	1.356	.672	2.735
	Constant	-.049	.433	.013	1	.910	.952		

a Variable(s) entered on step 1: age, sex, damp1, psmoke, pallerghx, cpet, grainbin.